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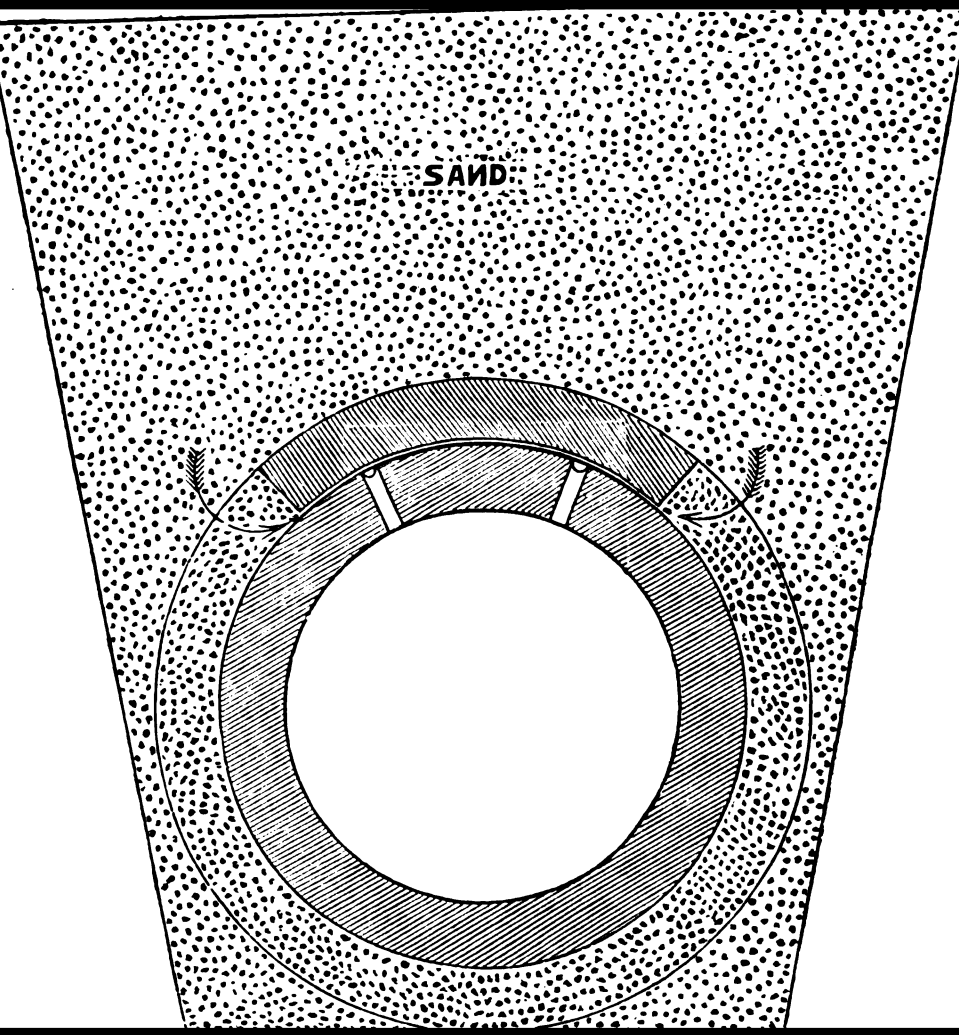

Report of the Committee Appointed to Take Into ...

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METROPOLITAN COMMISSION OF SEWERS
AUG. 20
1849

Isabella Mary Martin

REPRINT OF

REPORT OF THE COMMITTEE

APPOINTED TO

TAKE INTO CONSIDERATION

MR. MARTIN'S PLAN

FOR

RESCUING THE RIVER THAMES FROM EVERY SPECIES OF POLLUTION.

1836.

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LIST OF THE COMMITTEE.

CHAIRMAN.

The Right Hon. LORD EUSTON, M. P.

DEPUTY-CHAIRMEN.

Col. SIR FREDERICK TRENCH, M. P.

Major-Gen. SIR PATRICK ROSS.

COMMITTEE.

The Honourable RICE TREVOR, M. P.

J. BRITTON, Esq. F. S. A.
J. I. BURN, Esq.
R. DIXON, Esq.
G. FOGGO, Esq.
A. A. GOLDSMID, Esq.
A. B. GRANVILLE, M.D. F.R.S.
W. INMAN, Esq.
A. LAWSON, Esq.
I. MARTIN, Esq.
W. C. MYLNE, Esq.
N. OGLE, Esq.
B. SYDENHAM, Esq.

HONORARY SECRETARY.

T. G. MARGARY, Esq.

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So many have advanced claims for the honor of originating the momentous subjects of "Health of Towns"—"Purification of Rivers"—and "economical application of town refuse to the land"—that it is only an act of justice to invite attention to those who were actually amongst the earliest movers in the cause, and who labored earnestly at a period when their efforts were met by the ridicule and opposition of the ill-informed or interested; I have, therefore, esteemed the present a fitting time for reprinting a Report upon my Thames Improvement Plan, which emanated from a Committee of Noblemen and Gentlemen in 1836, and have appended the names of those distinguished supporters, many of whom liberally contributed their money, and still more valuable time and talents towards promoting the plan on public grounds, and with such effect, that if the Government had made the same demonstrations in 1836 as it has done since, the whole question of Sanitary Improvement would have been triumphantly carried.

JOHN MARTIN.

REPORT

Of the Committee appointed at a General Meeting held at the Right Hon. the EARL of EUSTON'S, M. P., in Grosvenor Place, on 3rd March, 1836, for the purpose of taking into consideration MR. MARTIN'S Plan for rescuing the Thames River from every species of Pollution,—for the improvement of the Wharfage,—the establishment of two great Public Walks,—and for other objects of public utility and importance; and to Report their opinion to another General Meeting.

THE Committee having held several meetings, at which Lord Euston presided, with a full attendance of the members, including Major-Gen. Sir Patrick Ross, Deputy Chairman; and having deliberately, and with great attention considered the various statements, facts, calculations

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and designs which were lain before them by competent persons, in explanation and illustration of Mr. Martin's Plan, have agreed to the following Report.

1. Ever since the year 1819, and more especially since the inquiry before a Royal Commission, dated July 1827, and before the several Committees of the House of Commons, which sat in 1821, 1828, 1829, 1831, and 1834, on the supply of Water to the Metropolis, drawn from the River Thames, the Inhabitants of London have been, more or less, in a state of excitement and anxiety respecting their supply of water for domestic purposes. The various General Meetings of housekeepers held, from time to time, at which the Marquis of Salisbury, the Earl of Jersey, the Earl of Hardwicke, Lord Warncliffe, Sir Francis Burdett, Sir Henry Halford, and many other distinguished individuals, took an active and prominent part; and the several petitions presented to the two Houses of Parliament on the subject prove that fact. On the other hand, the Government has, during the same period, shewn a corresponding, and an equally constant desire to see justice done to the public; and successive ministers of the Home Department have, by their authority and influence, endeavoured, but hitherto without success, to accomplish that object. The Water Companies, on their part, have not been remiss in suggesting, or considering various plans for obtaining purer and less objectionable water for their consumers,—without coming to a satisfactory conclusion; so that, in fact, the supply continues as polluted as ever; nay, more so than it was, when the first complaints were raised against it, seventeen years ago, in consequence of the additional number of drains terminating in the River, established since that time. No attempt has been made, even by the Water Companies, to deny the truth of this assertion: and the Thames, to this day, receives the excrementitious matter

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from nearly a million and a half of human beings; the washings of their foul linen; the filth and refuse of many hundred manufactories; the offal and decomposing vegetable substances from the markets; the foul and gory liquid from slaughter-houses, and the purulent abominations from hospital, and dissecting-rooms, too disgusting to detail. Thus that most noble River, which has been given to us by Providence for our health, recreation, and beneficial use, is converted into the Common Sewer of London (as stated by every witness examined before Parliament), and the sickening mixture it contains is daily pumped up, with the water as a common beverage for the inhabitants of the most civilized capital in Europe. The statement that, at every tide, this revolting accession to the stream is swept away to the sea, has been disproved by the evidence of impartial and well-qualified witnesses, who have shewn, that the load of impurity in question is conveyed by the ebb a few miles downwards to the east, then by the flood, repassing London, conveyed back again to the west; and that it neither reaches Teddington nor the sea. So far, therefore, from the tide purifying the water, it must tend greatly to facilitate the solution of all the most objectionable impurities thrown into it, in consequence of the to and fro movement which takes place in the stream immediately in front of the metropolis, and which, by churning, as it were, all the impurities, serves to generalize the pollution of the the River. Nor is this universal pollution of the water aided in a small degree by the frequent agitation produced in it by the numerous Steam vessels which ply constantly from below London Bridge, to beyond the remotest Western Bridge of the London district, and whose revolving paddles, as constantly, stir up the mud, the sediment, and every species of ordure.

2. The Plans hitherto devised to remedy so great a pub-

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lic evil, either by the Water Companies themselves, or by private individuals, and proposed to Government or to Parliamentary Committees, have led to no satisfactory result; for they either promised remedies ineffectual, or were attended with almost insuperable difficulties, particularly as regards the expenditure of public money, and the establishment of additional heavy rates on the consumers of water. Those plans may be divided into three classes:—1st, those which propose the purification of the water, either by filtration or subsidence; 2nd, those which suggest the pumping up of the water from a higher part of the River than where it is now obtained; 3rd, those which recommend to draw the supply from other sources than the Thames, and convey it by means of extensive aqueducts to London. Respecting the *First Class*, the Committee entertain a well founded conviction that filtration through sand (as in the case of the Chelsea Water-works) is quite insufficient to free the water from animal impurities held in solution, though it produces a clear fluid, free from sediment and colour:—that filtration through charcoal which would deprive the Thames water of part of the said impurities, is by far too expensive ever to be undertaken by the Water Companies;—and, finally, that the method of subsidence in Reservoirs, adopted now by almost all the Water Companies, is not only ineffectual for the removal of the organic impurities held in solution in the water, but is also an imperfect method of depriving it of the muddy sediment found, to this day, at the bottom of all cisterns to which the water is conveyed. Of the *Second Class* it is only necessary to observe, that unless all the Water Companies, north and south of the Thames, were simultaneously to establish their Works as far to the West as at Teddington, no removal, to any part within the influence of the tide, could accomplish their intention of supplying

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pure water to the Metropolis. The Bill obtained last year by the Grand Junction Water Company, for establishing their engines and pumps below Brentford, has given general dissatisfaction to the householders of Westminster, who held a public meeting in April 1835, for the purpose of protesting against it, as a measure manifestly inefficient in its provisions towards supplying a less objectionable fluid. In regard to the *Third and last Class* of projects submitted to Parliament, the Committee need only to state in passing, that the one which seems to have been duly considered by a select Committee of the House of Commons, so late as 1834, and which was presented by the late Mr. Telford, involves so much difficulty, and the outlay of so exorbitant a capital for the supply of six only, out of the eight Water Companies, that there appears to be no likelihood of its ever being carried into effect. It is not probable, indeed, that any Government will authorize the expenditure of £1,200,000 for the erection of two aqueducts, the one *sixteen*, the other *six* miles in length, according to Mr. Telford's estimate, in order to bring water from the Verulam and the Wandle to assist six only of the Water Companies of the Metropolis.

3. The inefficiency or impracticability of all these Plans, and the universally admitted existence of a most serious grievance, which the best endeavours and unceasing vigilance of Government have hitherto proved insufficient to remove, has, to this day, maintained the public mind, respecting this vital question, in that state of excitement which has now existed upwards of seventeen years. In this state of difficulty, it was given to the genius of Mr. J. Martin to devise, the simplest, as well as the most completely effectual plan for affording, at once, all that the public require, without injury to the rights and interest of the Water Companies, or interference with them; but, on

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the contrary, with manifest benefit to them, by saving any further outlay of capital, which they might think themselves called upon to employ in fruitless endeavours to satisfy public opinion. This Plan may be defined in a single sentence. It consists in diverting altogether, from the River, every possible source of pollution within the London district; so that the water sup plied from it to the inhabitants by the existing Water Companies, shall become as unobjectionable as a noble River in its natural state ever offered to man:—for according to Dr. Bostock's evidence, given before the Royal Commissioners in 1828, "the water of the Thames, when free from extraneous substances, is in a state of considerable purity, containing only a moderate quantity of saline contents, and those of a kind which cannot be supposed to render it unfit for domestic purposes, or to be injurious to health." The manner in which Mr. Martin proposes to accomplish this object is by the construction of a close Sewer, twenty feet wide, and of adequate depth, along both banks of the River, commencing on the north near Millbank, and proceeding towards the Tower, round which it will pass, if required, to terminate near the Regent's Canal; while that on the south, beginning at Vauxhall, and proceeding in the direction of Rotherhithe, is intended to diverge thence, and terminate near the Surrey Canal. In order to dispose of the polluting drainage thus diverted from the River stream, and confined within these two Sewers running parallel to the River, and with somewhat more than the declivity of its bed—Mr. Martin places two great Receptacles at their respective terminations, so arranged and constructed, that the accumulation of all the Drainage of the Metropolis shall not be productive of the smallest annoyance or insalubrity to the nearest inhabitants. With this view, a system of ventilation will be established, both for the great Sewers

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and the Receptacles, which will prove equally simple and effectual, whether the Committee adopt the one proposed by Mr. Martin himself, who has acquired much knowledge on this point, from having studied the ventilation of coal mines; or apply another, suggested by one of their members, equally competent for the task. In either case, however, the destruction of all noxious effluvia will be accomplished,—a consummation, which, coupled with the prevention (effected by the great parallel Sewers) of the hitherto frequent inroads of the tide into the lower ends of the common sewers, and the consequent backing of the drainage in them, together with other measures for excluding all offensive smells through the street gullies, will render the London drainage more perfect, and the labours of the Commissioners of Sewers less difficult.

4. Great and important as the first object unquestionably is, which Mr. Martin's Plan is destined to accomplish, it is not the only benefit which the Metropolis will derive from its being carried into effect. Although it seldom happens that in adapting any very extensive remedy to a public grievance, or in undertaking a work of magnitude for the good of the people, local and individual interests are not in some degree injured or invaded,—Mr. Martin's Plan has the additional merit of being little exposed to such an objection. On the contrary, his Plan, by the next object which it embraces, and which is, as it were, its natural consequence, is calculated to add to the value of most of the individual interests affected by the line of its operations. That object is the erection, over the two Sewers, of a line of COLONNADED WHARFS, which will afford, in front of the present Wharfs, additional room; increase the convenience of the merchant and the labourer, facilitate the operations of trade; give greater security to property landed from vessels and barges; improve the navigation of

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the River by the assistance of the subjacent Sewers, which will constitute uniform embankments; and, lastly, add some portion of time to the number of hours during which the craft can deliver or take in their cargoes. The immense and recent advances which mechanical science has made in this country will enable the Architect and Engineer, employed in the construction of these Wharfs, to take advantage of their uniform arrangement, and apply, through the engines required for the ventilation of the two great Sewers and Receptacles, either to the entire range of Wharfs, or to any part of it where it may be required, the power obtained from atmospheric pressure acting on a vacuum, which has been so sucessfully applied, of late years, to cranes and other machines, and which, in this case, it is presumed, would be gladly adopted by the proprietors of storehouses, manufactories and breweries, situated on the banks of the River, whereby another great advantage to those proprietors would be obtained from Mr. Martin's Plan. Respecting this useful application of mechanical science, the Committee have the satisfaction of being able to refer to the opinion of one of their members, who is perfectly acquainted with the subject.

5. But even this great metropolitan advantage secured by Mr. Martin's Plan, must yield the palm to another of a more popular and attractive nature, arising out of the accomplishment of a third object contemplated, also, by Mr. Martin. The Committee, therefore, feel particular satisfaction in having further to Report, that the same Plan offers the most favourable opportunity of establishing, at a comparatively small expense, a MAGNIFICENT PROMENADE on each side of the River, unequalled in Europe—by the conversion of the roofs of the colonnaded Wharfs just described, into parapetted Walks, to which the public will be admitted gratuitously on Sundays, and

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at the smallest rate of charge on every other day in the week. It is thus that the patriotic idea of Sir Frederick Trench will be realized, in respect to the erection of Quays on the banks of the Thames, without the liability to the several objections which powerful individuals and public bodies made to the purely ornamental and architectural project of that gallant officer, who, with high-minded liberality, has declared Mr. Martin's Plan to comprise more than his own, to be greatly superior in usefulness to the public, and to deserve his utmost support. It is thus also that the wishes, so often expressed, of late, by Parliamentary Committees, of affording to the mass of the population, the luxury, salubriousness, and recreation of great Public Walks, in the very heart of London, will be accomplished at once, and on a more extensive scale than has ever before been contemplated.

It would be superfluous, on the part of the Committee, to undertake to prove, that the establishment of a grand and magnificent Public Walk on each bank of the River, and behind a most crowded line of habitations running east and west of the Metropolis, must be of infinite service to the neighbouring inhabitants, by affording them an opportunity of taking exercise in a reserved Public Walk, (well calculated too for women and children,) and of enjoying a free and open atmosphere during the days and hours not devoted to labour, besides the benefit of a more direct intercourse. To these advantages they are certainly strangers at present, owing to their remote position from the Parks, and from every other general resort of pedestrians; and although a select Committee of the House of Commons did recommend, in 1833, an extension and improvement of the embankment along the River from Limehouse to Blackwall, at a considerable expense to the Parishes within that district—so partial a measure could

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only be useful to those whose residence is contiguous to the Walk, without being of service to the inhabitants of the more central parts of the Metropolis, along the North Bank of the River, where it is most required. On this point the Committee have obtained the opinion of one of their body, who is a medical man, and who, having practised for the space of twenty years as Physician to three extensive public Institutions in London, principally connected with the relief of the sick poor of the River districts, has had numerous opportunities of ascertaining the effect of the impure water of the River, of the confined air of the streets and alleys adjoining to it, and of the want of exercise, on the general mass of the inhabitants of those districts. The Committee specially refer to that opinion, in addition to that of the witnesses examined before the Parliamentary Committee of 1833, principally because, in a question so entirely belonging to the consideration of public health, the long experience of a medical witness is more likely to carry weight with those who have the protection of that health in their keeping. The want of means to take proper walking exercise, after a long day of laborious exertion, impairs the vigour of the body—produces among the working classes a morose and melancholy disposition—and engenders a spirit of dissatisfaction, which domestic privations are too apt to increase. Such feelings, in their turn, hurry their victims on to the resorts of the drunkard and the abandoned; where, if they imbibe not the spirit of discontent, they most assuredly sap the very foundation of their own health, and that of their future offspring. The Committee, fully coinciding also, in the sentiments expressed in the Report of the select Parliamentary Committee, just alluded to, on Public Walks, refer with particular pleasure to the part of that Report, where the peculiar natural advantages, which the Metro-

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polis might possess in respect to Public Walks on the banks of the Thames, are especially recommended to the consideration of the House of Commons.

There is one more public benefit, which the establishment of a great Walk on each bank of the Thames is calculated to secure, and which, hitherto, has not only remained unaccomplished, but has even escaped notice, namely, the protection of property on the River by night. It is a well-known fact, that taking advantage of the many hundred craft, which are left at night without a watch, and of the darkness, which conceals evil deeds, youthful thieves and others, commit considerable depredations on the River. The brilliant illumination by gas of the great walks, and, if necessary, of the Wharfs too, may be expected to put a salutary check to such guilty practices, and diminish the serious losses consequent thereupon; while the facility which the same Walks will afford to the Thames patrol, of overlooking every movement on the River, will complete this not insignificant advantage to the public. Connected also, with the establishment of the great quays in Mr. Martin's Plan, it will be found that an opportunity is afforded for the formation of large Public Baths, contiguous to the River, and so arranged that they shall not, in the least, interfere with the purity of the River Stream. Respecting the necessity and utility of Public Baths, as far as regards the health and cleanliness of the working classes in London, it is scarcely necessary to cite any authority. Upon that important subject, however, as well as on the general effect, which the extensive improvements and total changes effected, in the state of the River and its banks, by Mr. Martin's plan, will have, in greatly promoting the salubrity of the populous districts near the Thames—the Committee refer, with confidence, to the experience of the same individual

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whose opinion on Public Walks they have received, and who derives that experience from repeated observations made in London, and in all the principal Capitals of Europe—constituting a valuable corroboration of the testimony of well qualified witnesses given before the Select Committee on that subject.

6. The Drainage received into the great Receptacles, before mentioned, will be converted into manure, according to the method and practice very extensively adopted in China, on the Continent of Europe, and of late years, also, in some parts of Scotland. This will be conveyed by well devised arrangements, and under the influence of scientific measures, to different parts of the country, in covered barges, or properly constructed land-carriages. The value of this species of manure is almost incalculable. The best authorities place it far above every other, as containing, in much greater abundance, the very elements of which vegetable substances are composed, and on which their existence and growth depend. By saving, therefore, the vast quantity of it which has hitherto been wasted in the metropolis, a *Fourth*, and most important benefit—that of fertilizing, and rendering the land considerably more productive—will be conferred on the public, through the identical Plan, which alone can secure to us the luxury of drinking wholesome and unpolluted water.

7. On the financial part of a Plan so simple, yet so gigantic in its results,—a Plan, too, which seems encompassed by fewer difficulties requiring pecuniary sacrifices, than are generally met with in great public schemes, the Committee do not think it necessary to dilate at length. They have, however, duly considered the various elements and sources of income and expenditure connected with the existence and maintenance of so magnificent a National Work; and they have likewise endeavoured to calculate

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the probable outlay of money which will be required to carry it into effect. Positive information is not attainable at the beginning of any undertaking of this sort; though the talent and experience of persons the best qualified to judge in such matters, be summoned for that purpose. As long as the works are not undertaken, estimates can only be approximations. The Committee duly impressed with this truth, offer the first part of their financial statement, (without pledging themselves for its minute accuracy) as they received it from the Engineer who has signed his name to it.

EXPENSES OF CONSTRUCTION.

Erection of the two Great Sewers, 5 miles 530 feet, at £100,000 per mile	£510,000
Sewers from the Thames to the Receptacles, 2¼ miles, at £30,000 per mile	67,500
Receptacles, with Pumps and all necessary Machinery	150,000
Great Walks, 5 miles 530 feet, at £50,000 per mile	255,000
Probable Compensation	120,000
Surveying, Levelling, and preliminary operations	5,000
Act of Parliament	10,000
Contingent Expenses	100,000
General Total	£1,217,500

(Signed) RICHARD DIXON,
Fellow of the Institute of British Architects.

Such is the estimate presented to the Committee; but as considerable experience in matters of this kind enables many of its members to foresee the probability of Casualties in an undertaking of such magnitude, the Committee think, that *one million and a half* will be required to accomplish it in all its various ramifications.

Proceeding now to the consideration of the yearly expenditure for the maintenance of this great work, and of the sources of yearly income to be derived from it, the Committee believe that they may venture to Report them as follow:—

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INCOME.		EXPENDITURE.	
Manure	£200,000	Dividend on Capital at 8 per cent.	£120,000
Penny Tolls, 6 days in the week	70,000	Consumption of Coals .	5,000
Sewers' Rate, at 2d. in the pound	50,000	Repairs	30,000
Income for recovered Wharfage in places now waste	22,000	Management	14,000
		Wages	4,000
3000 horse vacuum power, at £15 per annum .	45,000	Contingences	8,000
		Total	£181,000
	£387,000	Surplus Balance	206,000
			£387,000

After the inspection of such a financial statement, assuming even that the surplus balance should not prove so considerable as therein stated, and as it is likely to be; the Committee still think, that Mr. Martin's Plan offers a safe pecuniary operation either for the Government to adopt, or for a Company to undertake, willing to execute that Plan under the specified and publicly expressed sanction and approbation of Government. Lest, however, the Committee should be deemed too sanguine and precipitate in their conclusions, they consider it necessary to state, that the opinion of several individuals belonging to a body of men, perhaps the best entitled, and certainly the best able, to form one on the subject—namely, that of the Institute of British Architects—is favourable to Mr. Martin's Plan, of which they expressed their approbation at their Meeting on the 29th of February last; when it was described to them by one of their Honorary Secretaries, and further explained by Mr. Martin himself. The letter of thanks to which this gave rise, expresses their approbation of the general features and objects of this scheme.

With this observation the Committee conclude their Report on this magnificent National Undertaking, the great objects of which may be thus recapitulated:—

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1st. The total and simultaneous subtraction of all filth, and of every species of ordure from the river stream; leaving it, therefore, in its natural purity.

2dly. The improvement of the wharfage property.

3dly. The establishment of a magnificent and extensive Public Walk along both banks of the Thames, unequalled in any part of Europe, with the consequent improvement of the navigation and general aspect of the River and its banks; the attendant amelioration in the local atmosphere and salubrity of that district; the protection of property on the River; and the formation of collateral public Baths, which shall induce persons to abstain from bathing in the Thames.

4thly, and lastly. The saving of a vast quantity of the most fructifying Manure, which, employed on cultivated soil, will nearly double its produce.

Subjected to the calculations of the mere man of business, these mighty results would, the Committee feel assured, be made the channel for a safe and lucrative investment of Capital. But the Committee viewing them as the means to a great end—THE WELL-BEING OF THE METROPOLITAN POPULATION—particularly of the middle and working classes, cannot forbear expressing their opinion, that the Enterprise assumes a much more noble character, and becomes worthy of the patronage of his Majesty's Government, the sanction of the Legislature, and the support of every individual who feels an interest in the prosperity, the happiness, and the glory of the British Empire.

London, 23rd April, 1836.

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APPENDIX.

The following Gentlemen, thinking the attainment of the objects contained in the preceding Report extremely desirable, are willing to concur in the consideration of Mr. Martin's Plan.

His Grace the Duke of Rutland.
The Marquis of Granby.
The Earl of Euston, M. P.
Col. Sir Frederick Trench, M. P. K. C. H.
Lord Eastnor, M. P.
Lord Ernest Bruce, M. P.
Lord Henniker, M. P.
Lord Mostyn.
Lord Dinorben.
The Hon. Francis Baring, M. P.
The Hon. Rice Trevor, M. P.
Sir Edw. Knatchbull, Bart. M. P.
Sir Charles Coote, Bart. M. P.
W. Alex. Mackinnon, M. P.
Col. Connolly, M. P.
W. Ormsby Gore, Esq. M. P.
W. Tooke, Esq. M. P.
John Fleming, Esq. M. P.
Horace Twiss, Esq. M. P.
A. Lawson, Esq. M. P.
J. E. Tennent, Esq. M. P.
Joseph Neeld, Esq. M. P.
John Benett, Esq. M. P.
Daniel Gaskell, Esq. M. P.
R. Potter, Esq. M. P.
Daniel O'Connell, Esq. M. P.
John O'Connell, Esq. M. P.
Maurice O'Connell, Esq. M. P.
Rigby Wason, Esq. M. P.
John Bodkin, Esq. M. P.
J. Heathcoat, Esq. M. P.
C. J. Hector, Esq. M. P.
Sir E. L. Bulwer, M. P.
H. L. Bulwer, Esq. M. P.
J. Ryle, Esq. M. P.
J. Brokelhurst, Esq. M. P.
Sir Oswald Mosely, Bart. M. P.
The Hon. E. L. Mostyn. M. P.
T. P. Williams, Esq. M. P.
Sir Richard Bulkeley, Bart. M. P.
Sir Augustus Clifford, Sergeant at Arms.
Sir George Chetwynd, Bart.
Sir George Duckett, Bart.
Sir Felix Agar.
Sir James Hope.
Major-Gen. Sir Patrick Ross, K. C. M. G. K. C. H.
Major-Gen. Sir Joseph Straton, C B. F. R. S.
Sir Isaac Lyon Goldsmid, F. R. S., G. S., S. A.
Aaron Asher Goldsmid, Esq.
Charles Hammersley, Esq.
Benjamin Wood, Esq.
Sir Anthony Carlisle, F. R. S.
Dr. Paris, F. R. S., L. S.
Dr. Granville, F. R. S., G S., L. S.
Dr. Copland, F. R. S.
Dr. Elmore.
Dr. Elliotson, F. R. S. Professor at the London University.
Dr. Kerrison.
Dr. Arnott, Author of "Elements of Physics."
Dr. G. G. Campbell.
Dr. Birkbeck, President of the Mechanics' Institute.
W. Maclure, Esq. President of the Harveyan Society.
Rev. Dr. Lardner, F. R. S.
Rev. Dr. Ritchie, F. R. S. Professor at the London University.
Dr. Bernays, Professor at King's College, London.
C. Wheatstone, Esq. F. R. S., Professor at King's College, London.

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R. Bligh, M. A. Barrister.

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W. Whitwell, Esq. Architect and Engineer

W. Inman, Esq. Architect.

James Noble, Esq. Architect and Surveyor.

W. Cowper, Esq. Civil Engineer.

G. Gutch, Esq. Architect, Surveyor to the Grand Junction Canal Company.

Charles Fowler, Esq. Architect of the Hungerford Market.

Charles Barry, Esq. Architect.

John Poole, Esq.

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William Jerdan, Esq.

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Theodore E. Hook, Esq.

Rev. Dr. Croly, Rector of Saint Stephen's, Walbrook.

T. J. Pettigrew, Esq. F R. S., S. A.

G. Newnham Collingwood, Esq. M. A., F. R. S.

Lieut.-Colonel Bagnold.

Lieut.-Colonel Sykes, F. R. S., G. S.

Col. Alexander, Commissioner of Sewers for Westminster and Middlesex.

Francis Bourdillon, Esq. do.

E. Halswell, Esq do.

W. Beach, Esq. do.

Frederick Crace, Esq. do.

W. Mountford Nurse, Esq. do.

T. Amyot, Esq. F. P. S. P. A. S. do.

Samuel Rogers, Esq. F. R. S., F. S. A.

C. L. Eastlake, Esq. R. A.

George Jones, Esq. R. A.

Lamie Murray, Esq.

W. C. Mylne, Engineer to the N. R. Company.

E. G. Atherley, Barrister.

Captain Doran.

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Sir Robert Sydney

The Hon. Col. Leicester Stanhope

The Right Hon. Sir Alex. Johnston, Bart. F. R. S.

Col. G. Hardy.

J. I. Burn, Esq.

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W. R. Hamilton, Esq. F. R. S., V. P. R. A. S.

E. Protheroe, Esq.

E. H. Maltby, Barrister.

W. Campbell, Esq.

H. Lloyd, Professor at Trinity College, Dublin.

Rev. W. J. Hutching, M. A.

D. Corrie, M.D. Birmingham, President of the Philosophical Society there.

Charles Thomson, Barrister.

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THE INSTITUTE OF BRITISH ARCHITECTS' LETTER

To JOHN MARTIN, ESQ.

43, King Street, Covent Garden,
3rd March, 1836.

My dear Sir,

As you were yourself present at the last ordinary Meeting of the Institute, held on Monday the 29th of February, you are fully aware of the intense interest, with which the Members received the description of your admirable project for improving the discharge of the Sewage of this Metropolis, and relieving the Thames from those impurities which now so materially injure its waters, and affect the health of the inhabitants.

I am, however, directed by a Special Resolution, passed on that occasion, to present to you the thanks of the Institute for having submitted this important subject to their notice. Perhaps this acknowledgment may not be considered by you the less valuable, as proceeding from a body of Professional Men, whose practical experience enables them, even from so brief a view of the subject, to appreciate, in a general way, the important results, which might arise from the adoption of a plan of such a nature.

I am, my dear Sir, with every expression of sincere regard,
Yours very faithfully and truly,
THOS. L. DONALDSON, HON. SEC.
And Corresponding Member of the Institute of France.

P. S. I am directed at the same time to enclose a Card of Admission to the Meetings of the Session, and to express the satisfaction the Members will experience in being favored with your presence whenever agreeable to you.

Additional Names since this Report was printed.

His Grace the Archbishop of Canterbury.

W. Ewart, Esq. M. P.

Joseph Houlton, Esq. F. L. S.

Rev. R. Walpole, B. D., Rector of Christ Church Mary-le-bone.

David Mocatta, Esq. Architect.

Sir James Cockburn, Bart.

The Lord Mayor, Copeland, as an Individual.

Alderman Farebrother.

J. Smith, Esq. Deanston, Civil Engineer.

The Right Hon. T P Courtney.

E. T. Foley, Esq. M. P.

Francis Giles, Esq. Engineer.

Joseph Comte de Survilliers—Joseph Bonaparte.

L. Maillard.

Joseph Douglas, Temple.

Ralph Thomas, Barrister.

Alderman F. G. Moon.

Right Hon. Lord Robert Grosvenor, M. P.

Edward S. Cayley, Esq. M. P.

Wynn Ellis, Esq. M. P.

Edward Basil Farnham, Esq. M. P.

Charles Wood, Esq. M. P.

Robert Aglionby Slaney, Esq.

W. H. Hyett, Esq. F. R. S. of Painswick.

Dr. Bowring, M. P.

Rev. John Connop, Bradfield Hall, Berks.

Rev. J. C. Blair Warren, Horkesley Hall, near Colchester.

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MARTIN'S

THAMES AND METROPOLIS

IMPROVEMENT PLAN:

THE OBJECTS BEING

TO SUPPLY THE METROPOLIS WITH PURE WATER;

TO EMBANK THE RIVER THAMES & PRESERVE THE SEWAGE;

TO IMPROVE THE NAVIGATION BELOW LONDON BRIDGE;

AND

TO CONNECT THE PORT OF LONDON WITH THE INLAND RAILWAYS.

THE FIRST DIVISION

Proposes to supply London with the Pure Water of the Thames, unmixed with the foul drainage, without the aid of Engines; and to improve the health, beauty, and navigation of the River above Hammersmith.

THE SECOND DIVISION

Comprehends the embankment of both shores of the River from Vauxhall Bridge to the Tower; the improvement of the Drainage of the Metropolis, and preservation of the Sewage for Agricultural purposes; besides many other great and collateral advantages.

AND THE THIRD DIVISION

Contains a plan for improving the Navigation and Banks of the River Thames below London Bridge, by cutting a narrow channel across the Isle of Dogs, and over Brickfield, shortening the distance two miles, leaving two large docks of deep water on each side of the channel; and for connecting this great port of London with all the inland Railways.

LONDON, RIDGWAY, PICCADILLY.

1842.

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PRINTED BY J. PLUMMER, PUDDING LANE, EASTCHEAP.

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MARTIN'S

THAMES & METROPOLIS IMPROVEMENT PLAN.

THE distress which at present prevails throughout the country, which has been long existing, and gradually increasing until it can no longer be borne, is acknowledged to arise mainly from the unprecedentedly great want of employment amongst all the labouring and productive classes; causing that, which should be the wealth of the country,—a crowded and rapidly augmenting population, to be regarded as a real evil, for which there is no apparent remedy but emigration; in other words, the choice of starving without work in their own country, or of going to a distant and barren land to labour, and, perhaps still starve. I have no intention, here, to enter into the original causes of this lamentable state of affairs; it is, at present, sufficient for me that our poor, honest, and able-bodied countrymen are willing to work in their native land, and at moderate wages; and that it is, therefore, the bounden duty of the legislature to supply them with remunerating occupation to avert worse calamities; for, as they cannot be allowed to die of want before our eyes, their support falls heavily upon the rest of the community, who already begin to suffer, and are becoming unequal to maintain so

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many idle consumers who afford no return. It is with these views and a firm conviction that we have at home ample means of productive employment for a population infinitely greater in amount, that I submit the following general observations and plans in a connected form to the public, with the hope that in the present juncture I may succeed in drawing attention to the necessity of advancing by every possible means, such works as would effectually and permanently benefit both the agricultural and commercial interests of the country at large. To promote such momentous objects, I would suggest that all parts of the country should be completely drained by a permanent filter drainage, deeply ploughed, and manured—that rivers be embanked from their very sources, with good flood gates, sluices, weirs, and locks, for the improvement of the navigation; that even the banks of the tributary rivulets should be lined where they are soft and earthy, to prevent the water from becoming muddy, choking the bed of the river, and thus injuring the navigation. By such means all bogs, marshes, and the immense flats along the banks of the Thames, Lee, &c. would be rendered most valuable land, and so much improved in health, that mansions might be built, and fertile gardens, orchards, and parks, formed on spots now only dreaded as the sources of pestilence, fevers, and agues.

After establishing a complete system of land drainage, and cultivation, as the means of producing what is necessary to subsistence, the next essential point is to effect an equally perfect system of town drainage and ventilation of houses, streets, &c. as the means of contributing to the health and comfort of the community. All our most eminent medical men, have attributed the ravages of the Cholera, Typhus, &c. in the closely built and populated

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districts, solely to the absence of a proper system of drainage and ventilation; and when we consider that the pestilence does not confine itself to the place where it originally breaks out, but spreads in every direction, the establishment of a uniform sanatory system, more especially in such localities, becomes of the most deep and serious moment to all. The best manner of effecting these desirable objects appears to me the appointment of local boards with scientific managers, at the head of a sufficient number of men, to direct the levels, &c. and to adequately remunerate the labourers employed; for, as there is no wealth without labour, the better paid and, therefore, more effective the labour, the more wealth will ensue, and peace, plenty, and a smiling land, with satisfaction on every countenance be, ere long, the certain result.

Without offering further preface, I will proceed to the description of some propositions which in some degree carry out my views, and detail three specific plans, one of which,—"The Embankment of the Thames,"—has already been long before the public. Plans of improvement, however, require to be made public for years before they are fully understood or appreciated; and after labouring in the cause for fifteen years, and seeing the eyes of the more enlightened gradually opened to one or other of the various objects I have promulgated, I have at length, the satisfaction to find a clearer and more just view acknowledged of the necessity and practicability of the whole, and am consequently induced to submit it, together with the additions, in as complete a form as is consistent with conciseness; always impressing the practicability of effecting any one of my objects either in part, or wholly: but urging that the portion so taken, should be in strict accordance with the general plan, so that at any future time it might be resumed and carried further.

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To facilitate the description of the following project, I have separated it into three divisions—The supply of water to the Metropolis:—The embankment of the River, and preservation of the sewage:—And the improvement of the navigation of the River from London Bridge to the Nore: each division being in itself a distinct plan, not dependant upon the others; and the whole combined, forming one grand and general plan for the IMPROVEMENT OF THE THAMES.

FIRST DIVISION.

A plan for supplying London with the pure Water of the Thames, unmixed with the foul drainage, without the aid of engines; and for improving the health, beauty, and navigation of the River.

Objects of the Plan.

I propose to separate the tide waters and filthy drainage of London from the stream,—to give an abundant supply of water to each house, from the lowest to the highest level, at the distance of only four miles from London and its suburbs, without the assistance of engines; that even in time of flood the water shall enter the pipes in as bright and pure a state as when it gushes from its native springs, instead of entering from the present stagnant and fermenting reservoirs,—to afford Public Baths,—running fountains for Kensington and Buckingham Palace Gardens, to Hyde, Green, St. James's, and the Regent's Parks, leaving no stagnant waters in the Metropolis; and lastly to improve the health, beauty, and navigation of the River.

Weir across the Thames.

To effect these great objects, I recommend the construction of a Weir across the Thames, about a mile above Hammersmith Bridge, from the proximity of this point to

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the public road, and to the Dolphins of the Grand Junction and West Middlesex Water Companies. This Weir should be as high as mean high water mark, with a moveable flood gate to equalize the height of the water in extraordinary tides. The tide and foul drainage being thus separated from the pure waters above the Weir, the property and beauty of the residences and walks along its banks would be proportionately improved, and the River would be secured as a never failing reservoir of healthy running water, sufficiently deep to be at all times navigable up to Teddington, affording the advantage of an invariable high tide; for such is the fall that the whole space would be filled in the course of one tide, as much water being found to run down with the stream, as flows up with the tide, besides being free from the objections which attach to plans, deriving the supply at a higher level, or at the Colne, amongst the most important of which are compensation for Mills, (£100,000 according to Mr. Telford's plan, taking the supply at Bushey Mill,—and my own from Denham); and the great injury to the river between Staines and London, consequent on abstracting so much water, as would be required for the supply of the Metropolis. As there would be a fall of the whole body of the Thames over the weir of 12 feet, which fall would be increased at low water, and in settled dry weather; it is obvious how advantageously this power might be applied to working pumps and water wheels, without employing engines (thus effecting a vast saving of expense and nuisance) in a manner similar to the great water works at Philadelphia, where wheels have superseded the engines, yielding twice the quantity of water at a cost of exactly *one tenth*. Some idea of the expense of engines and reservoirs may be formed when we learn that the Grand Junction Company alone has expended down to September

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1833, no less a sum than £127,260 upon engines, engine-houses, reservoirs, and the value of land for their formation. Other companies have proportionate expenditure; and exclusive of the money so sunk, Mr. James Simpson, the intelligent engineer of the Chelsea Company, has stated in evidence before the Committee of the House of Commons, upon the Metropolis Water Supply, 1834, that the annual expense of maintaining this engine power, is £25,000.—It is so needless, however, to adduce evidence of the power and economy of water wheels: that I will no longer delay detailing my proposition.—In order that the water should at all times enter the pumps perfectly clear, without using settling or other reservoirs, it should be taken from the upper level, having first passed through filtering strainers of double horse-hair, with sand between, and should then be raised by pumps to a hydraulic tower at each end of the weir, for the purpose of supplying the various levels on both sides of the river. These towers should be constructed on arches, the lowest arch 100 feet above high water mark, to support the cistern for the ordinary levels,—the next arch 150 feet, supporting the cistern for the next level,—and the third and smallest 30 feet higher for the highest levels. A certain number of pumps would be applied to work up to each of these cisterns, the pipes descending from which would be connected with each of the Companies mains, and the pure water flowing thence to the highest points of the various districts, there would be none of those delays in cases of fire which we have constantly so lamentably to deplore. The superabundant waters in time of flood should be let off by means of a sluice and channel connected with the river above and below the weir (see plan), the banks lined with slate planking (see plan) where they may require it, and a sufficient

Reservoirs not needed.

Hydraulic Tower (see plan)

Immediate supply in cases of fire.

Means of letting off the waters in time of flood (see plan.)

Banks lined with slate planking (see plan)

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towing path formed on the right, and foot path on the left bank, thus uniting this point with the embanking of London, and making one grand walk extending from Twickenham to the Tower. To prevent the pollution of the river from the populous places above the weir, covered receptacles should be formed (see "Plan for preserving the sewage for agricultural purposes") to receive the house drainage of every town, village, or hamlet along the banks of the Thames and the tributary streams; which sewage should be pumped up and distributed over the neighbouring lands. In confirmation of the advantages of this proposition for backing the water, I have the valuable testimony of Mr. Leech, the river surveyor, who was opposed to my former plan for making a weir between Vauxhall and Battersea, upon the ground of its obstructing the navigation; but he has since expressed to me his change of opinion and conviction, that instead of impeding it would greatly improve the navigation.

Public Walk.

Small receptacles at Brentford, &c. for the sewage.

Manuring the lands.

Having thus completed the first division of my Thames Improvement Plan, I proceed to describe the

SECOND DIVISION.

Plan for embanking the River Thames from Vauxhall Bridge to the Tower; and for the preservation of the Sewage for Agricultural purposes.

The objects of the following plan are first to materially improve the drainage of the Metropolis; secondly, to prevent the sewage being thrown into the river, so as to preserve in a pure state the water which the inhabitants are,

Objects.

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as yet, necessitated to use; thirdly, to prevent the pollution of the atmosphere by the exhalations from the river, and at the open mouths of the drains; fourthly, to save and apply to a useful purpose the valuable manure which is, at present, wasted by being conveyed into the river; besides many other great and important collateral advantages.

Receptacles at the end of the great sewers, above Vauxhall Bridge.

My proposition, in the first instance, as formerly, is to preserve the whole sewage of the western extremity of London, by diverting it from the river into receptacles above Vauxhall Bridge, forming one at the termination of the Ranelagh Sewer. The great sewer which now disembogues below Westminster Bridge, should be continued along Parliament Street, Abingdon Street, and Milbank, all the minor drainage above the Houses of Parliament being turned into it, and be finally discharged into the receptacle at the termination of King Scholar's Pond Sewer, effecting great benefit to this inadequately drained part of the town, without entrenching upon existing interests. The ground should be recovered at various points above the Houses of Parliament, (see plan) and a public walk and drive formed, uniting with the proposed weir, and making a beautiful drive from Pimlico

For the City.

along the banks of the river. For the body of the city I propose to continue the uniform embankment, and to form ~~a line of~~ an intercepting sewer, commencing at Hungerford Market, passing ~~before or~~ behind the different docks, &c. and receiving all the minor drainage in their course, with a small receptacle near Hungerford Market to receive the contents of the Sewer as far below as Essex Street; where the fluid should be pumped up a pipe to the receptacle at the nearest railway, or convenient elevation. The general line of the intercepting sewer being laid down,

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it should be divided into portions of from a quarter of a mile to a mile or more, according to the convenience of the localities, and the works always commenced at the lower end, as by these means each division could be executed independantly of the rest, at greatly diminished expense; the requisite fall and size of the sewers being small compared to what would be necessary in the continued line. The end of each portion should be completed, having pipes which would act like syphons in conveying the sewage, previously stirred by a revolving bar, to the elevated receptacles, or into covered barges, using a pump when it should be very low, and a sluice to let off superabundant flood drainage, the whole works being effectually covered to prevent any contamination of the air. Small floating piers should be attached to the embankment, forming docks for barges, allowing the unimpeded flow of the water, and the full advantage of an unbroken line of embankment free from recesses for the accumulation of mud, and from the unsightly and disgusting mouths of sewers and drains.

To be executed in portions commencing at the lower end.

Whole works covered in.

So far as these ~~sewers~~ embankments would extend, it is obvious how much the houses on the banks of the river would be augmented not only in health and beauty, but in utility. As a further improvement, I therefore, recommend the erection of colonnaded wharfs upon the quay, at intervals, where the traffic is great, as between Blackfriars and London Bridges, to afford additional room, thereby further increasing the convenience of the merchant and labourer, protecting the merchandise from the weather, screening the work from observation, giving greater security to the property landed, and prolonging the time during which the craft could deliver or take in their cargoes. The tops of these colonnaded wharfs and quay would form a healthy

Covered Wharfs along the quay.

Advantages.

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and magnificent public walk, which should pass either over or behind the docks at Scotland Yard, and on the line. These docks should be one half in the solid embankment near the shore, the beds being levelled and lying high and dry at low water, to facilitate the loading and unloading of vessels, the other half being always deep water, maintained by floating piers, which would rise and fall with the tide, and project only a stated distance, beyond which none should be allowed to advance, or vessel be moored, thus allowing the landing or loading at all times. As the water would pass and repass freely underneath the piers, this part of the dock could never choke or become foul, and even the inner half could not become so foul as it would were the whole solid. By these means not only would the wharfage be increased, but the navigation facilitated from the uniform embankment; the docks which are, at present, little better than open receptacles, would be greatly benefited, and a great saving in cleansing them effected, the health of the air and quality of the water improved, the sewage saved for manure, land recovered where it is of the greatest value, public baths constructed, and a grand public walk formed through the most populous and richest part of the City, where it is most needful, shortening and rendering more easy the distance between Vauxhall and the Tower, relieving the streets of a great portion of their over-crowd, without impeding the traffic of the wharfs, or the wharfs interfering with it, besides the power when the walk is completed, of erecting shops, mansions, or public buildings, where they would be of the greatest value, both as to trade and grandeur of appearance; and lastly, a work unequalled as a whole in either ancient or modern times would thus be produced, to remain a useful and magnificient monument of our own age. For the south side

Floating Piers.

Capt. Bullock's observations.

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of the river ~~I propose to work only with receptacles at the end of the great sewers, one being formed at the termination of the Effra Sewer at Vauxhall; and instead of the sewers upon the shore~~, all the minor drainage should be turned into the Great Duffield, or any other main sewer which runs from Vauxhall to Bermondsey, which should discharge itself into a receptacle at some convenient spot opposite the London Dock, near the great Surrey Canal, or even lower if expedient; the bank should then be rendered equally useful by the formation of quays even more capable of being ornamentally diversified according to the situation of the ground. In this way the Surrey shore, which, from the numerous docks and other obstacles, has always been considered the most difficult, will be easy of execution, every objection being removed, and all the advantages of a uniform ~~sewer~~ quay afforded at greatly diminished expense. As regards the receptacles it is not advisable to make them very large and deep, for the manure is found to be so much more efficient when liquid, that it is desirable to preserve it in that state, and it could, therefore, be removed as it enters, at small expense, by the application of a simple hydraulic principle. In time of flood sluices should let the sewage pass freely into the river, and sweep the drain clean as it does at present, but without the disadvantage of being backed by the tide, which renders the existing sewers for twelve hours out of the twenty-four mere cesspools, the mouths being closed by sluice gates, but for which, every house in Westminster, even as far as Park and James Street, would be inundated by the filthiest of floods; this would not affect the general system, as the small portion of sewage lost would be so diluted with flood water as to be of comparatively little consequence, especially for such a short period of the year, and so very seldom;

For the south side of the river a receptacle for the Effra sewer at Vauxhall.

Receptacle for the Duffield Sewer, near the Surrey Canal.

Large Receptacles not necessary

Sewage allowed to escape freely into the river in time of flood.

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neither would the river be injured by the superabundant drainage, as the violence of the floods would scour and force it away to the sea almost at the first tide. These gates, however, should always be closed to keep back the tide in the summer, when the sewage is richest, and of the greatest value, though smaller in quantity, as it could be wholly removed even faster than it entered, effecting the most important benefit; for at this period of the year, when pure water is most required, the river is lowest and most injured by the sewage entering at such a high point of the town. In order to render a system of town-drainage completely effectual, the foundation of the buildings should be as elevated as possible, and the house should be separated from the rain or surface drainage, each house having two drains, one being small, and conveyed by means of a larger drain direct to a closely covered receptacle in a convenient place in the district; and the other for the surface or flood drainage flowing off into the main sewers, sweeping and scouring them: thus large receptacles would not be required, the surface drainage not being allowed to enter, and every particle of the valuable fluid manure would be saved without the possibility of escaping into the river. The plan of forming receptacles should be adopted wherever the main sewer is not sufficiently capacious at the lower end, to receive any accession of sewage, as would have to be decided by the Commissioners of Sewers upon actual survey: it is also peculiarly applicable to poor, crowded, and as yet undrained, districts like Spitalfields and Bethnal Green, and to the suburbs and extremities so distant from the river as to require a length of drain, for the receptacle would cost only a few hundred pounds, whilst the sewer would cost as many thousands, besides the lower drains being relieved of an immense body of drainage, might be made much smaller, and no smell could

During summer sluices closed to keep back the tide water, and preserve the sewage from waste.

Separate drains for each house, one for the house, and the other for the flood drainage.

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come from the gullies, as only rain water would flow down the sewers. I am well aware that in a city like London this system could not always be carried into effect, excepting in new houses, but it might even be adapted to the existing system by making the house drain on the top, or a little on one side of the great drain, keeping as near to the surface as circumstances would admit that they should not intercept each other, or be so difficult and expensive to form; thus accomplishing the important objects of keeping the drains high, separating the house drainage from that of the surface, and preserving the manure unmixed with superabundant water, and consequently more easy of transport. Each village should have its receptacle, to separate the house from the land drains,—for example, the house drainage of Hampstead should not be suffered to poison the air and water between it and Kentish Town—the drainage of Kentish Town should not run to Camden Town, —nor that of Camden Town flow on to London: and by these means all the valuable manure would be secured from waste, the nuisance abolished, and both liquid and solid manure ready on the spot to transport to any part of the country.

Double drains to all future new houses.

Receptacles to every village.

The valuable particulars relative to the river, which I have obtained through the instrumentality of the Admiralty, and the facilities liberally and kindly afforded by the Commissioners of Sewers, and my distinguished friend Mr. Thos. L. Donaldson, have enabled me to gain important information as to the fall necessary for sewers according to their dimensions. One result of my enquiries and observations has been the possibility of having too much fall, for when I had the honor of accompanying the Commissioners of Sewers in their inspection of the drains, upon going along King's Scholar's Pond Sewer, I remarked that

Too much fall objectionable.

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Friction from too great fall.

where there was too much fall, the friction was so great that the bottom would soon require repairing; that in no place was there too little fall; and that where the sewer had a proper inclination, the bottom was not in the least worn. A river with a fall of four inches in the mile does not wear its bed, nor leave a deposit, but with less than four inches it leaves a deposit, and with more than six it wastes the bottom; the inclination, however, must always be in proportion to the size of the drain or channel, and the smaller these are, the greater is the requisite fall, for instance, that leading from the house and offices cannot be too great, and should simply be formed of tile, with a slate cover, and a trap to keep back the rats and smell. I advise, also, that my principle of trap should be applied to the heads of drains, and to the gullies in the streets, thus protecting the sewers from the stones, grit, and other rubbish which are found to choke them, and preventing the disgusting smell which arises in particular states of the atmosphere. An objection of the danger from foul air by thus trapping the drains having been made, I can only reply that it is entirely without foundation, as the ventilation of any part where the repairs might be required, could be effected by simply raising the valve of one trap on each side of the place to be repaired or entered, and placing a small covered fire place over them, to be supplied with no air but that which comes from the drain, upon opening the man-hole the external air would immediately rush in, sweep to each of the fires, and render it perfectly safe between for the workmen, whilst the draught being inwards, no foul air could escape into the streets. This manner of preserving the manure from waste, and water from pollution, should be adopted in every town, village, and even cottage, throughout the country. There are however many opinions as to the best manner of conveying, distributing, and ap-

The inclination should be in proportion to the size of the channel, the smaller the drain, the greater the requisite fall.

Trap to prevent the drain from choking, and smell escaping.

Ventilation of the drains.

Small covered fire places to be occasionally used

Plan to be used in all parts of the country.

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plying the manure when preserved. Mr. B. Smith, M.P. a member of the Agricultural Board, who has great experience in agriculture and the use of fluid manure, calculates that the manure which is thrown into the Thames would produce, if properly employed, equal to £7,000,000 per annum, and therefore, that however difficult the means, or great the expense, it ought still to be preserved: he advocates conveying it by pipes, pumping it to all the elevated spots along the sides of the hills, and letting it flow down the slopes according to the mode used at Edinburgh; and this would perhaps ultimately be the cheapest mode of conveyance, for the fluid manure could be carried at the same cost as water that is, a distance of twenty miles, at 2d. a ton. I venture, however, to object to the plan of flooding the soil, by which the manure runs too much into the hollows, leaving the elevations clear, ~~and this~~ must always be the case, unless the ground has an equal slope, ~~otherwise it would be impossible to flow it over a wide plain,~~ but the worst evil of all would be the injury to the air of the whole country round: to apply it therefore, I should recommend in preference, simple carts, covered, and made like watering carts, as the fertilizing matter would thus be spread equally and mix more readily with the soil on dry and sandy land, on either hill sides, hollows, or wide plains, no one part having more than another; there is also less labour in thus distributing the manure, the cart being emptied as it progresses, the manure goes at once to its work, instead of lying in disgusting heaps, requiring additional labour to spread it, and even then when it is spread, it cannot act till the rain converts it into fluid. The consideration which I have so long given to this most important subject, leads me, here to propose a system of distributing the manure, which appears to me to be greatly superior in economy and efficiency to the foregoing, or to any at present in use:—it is to apply the well known principle of

B. Smith, Esq. M.P.

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fluids finding their level:—thus, to convey the sewage in its most fluid state, by means of pipes, from the principal receptacle or great sewers, and to then pump it up into a small receptacle or Hydraulic Tower of sufficient elevation, from which a pipe should descend, and be laid down into the centre of the tract to be manured. A cock and strong caoutchouc cloth hose, with one or more small branches, should be attached to the extremity of the pipe, and a swivel cock placed at the junction of the branches to allow of their being easily moved round; by these means, each hose being guided by a man, the manure could be turned on, and projected in every direction in the same way as the firemen discharge water upon a fire; and, without moving the main hose, a space of three miles in circumference could be manured with only one half mile of iron pipe, the same hose serving to manure the whole tract, and be then readily transported to another locality. (see plan.) Although I consider this the most efficient, rapid, and the cheapest mode of distributing the manure, yet if carts should be thought by others desirable, the pipes should be laid in the following way. Supposing a tract of land one mile square, the point of elevation should be on one side about a quarter of a mile from the corner, and the pipe laid from thence in the form of a square, the sides of which should be a quarter of a mile from the outer boundary of the land, giving a length of pipe of two miles, with cocks at intervals of a quarter of a mile: the manure vehicle could thus never be more than that distance from the point of supply, and the superior elevation of the receptacle would force up the fluid at each cock in the way seen in supplying water in the streets of London. To manure one division of the tract, two cocks would be at work, to each of which a small hose should be attached, to facilitate supplying the cart without its having to go over unnecessary ground, thus a square of a quarter of a mile could be manured by a man, and horse

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and cart in two days. It is, however, obviously the province of the Agricultural Board to consider and settle whether the manure should be conveyed to more distant parts by pipes, covered barges, or railway waggons, and deposited in places prepared for the purpose in the vicinity of the agricultural districts. Large pipes should be laid down from the large sewers and receptacles, to other receptacles at the nearest railways, where covered waggons could be instantly filled, one or more of which should be attached to each country train; and covered barges should be employed upon the canals and navigable rivers, as the capability of transporting the manure and returning the produce would thus be immediately increased, and at infinitely diminished expense, for " one horse will do as much by canal as thirty can by the common road:" as Dr. Arnott states in his admirable " Elements of Physics." The places for depositing the manure should never be selected near populous districts, since such spots could produce a sufficiency for the use of the immediate vicinity; and thus by a judicious distribution and careful application, poor and now unproductive lands would be rendered rich and fertile, very soon returning in produce more than the amount expended in forming the drains and receptacles. It is especially important that the plan of intercepting sewers should be applied to our sea-ports. I will take Brighton for example, where instead of inhaling the pure fresh sea breezes, we are disgusted at the foul and filthy air from the mouths of the drains and iron pipes, which poison the air, and even the sea at the bathing places. To remedy this, an intercepting large pipe should receive all the drainage of the separate pipes; this main pipe should have its fall to the west, and be carried out near Hove, where the sewage should flow into a covered receptacle, and be thence removed to manure the fields and downs in the neighbourhood; all which could be effected at moderate small expense, there being

The manure transported by canal, or otherwise to depots at stated distances.

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no excavations excepting for the receptacle. Wherever it is difficult to drain by grand sewers, covered receptacles, with facilities before described for carting off the manure to the nearest fields or gardens, should be used; even each detached house, standing at a distance, should have its covered cesspool; for the necessity of preserving every particle of manure cannot be too strictly impressed, it being as requisite to give the land support to enable it to yield, as that the labourer should have sufficient food to strengthen him for his daily labour: besides which, the health of the surrounding country demands the enforcement of some such measures, for it is not the infected place alone, but the part towards which the wind blows, which suffers, as it is recorded that during the last great plague of London, the wind set in for a long time from the east, and carried with it the foul exhalations which arose in that quarter to *the west*, where the ravages *first commenced,* afterwards gradually creeping eastward. This affords proof of the danger of building low neighbourhoods without proper drainage and traps, and many such can be instanced, indeed the wind can scarcely blow but in the line of one of these rookeries. Portland Town, and the vicinity of Portman Market, for example, are a disgrace to the landholder, who for the mistaken sake of present gain, has poisoned Marylebone, and in reality in a pecuniary point of view permanently injured a valuable property.

Plan carried out in Gardens, Parks, &c. by forming small receptacles for the drainage.

This plan could be carried out in parks and ornamental gardens, like Kensington Gardens, where I would suggest forming a small receptacle, or cess pool, at the upper end of the Serpentine, for a portion of the drainage of Bayswater, &c. which should then be employed in manuring the gardens either by the hose or carts; and if this were done early in the morning before the opening of the gates, no vestige of manure would be seen.

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If the Government would try this system on the crown lands, it would afford an admirable example to the nation, and render lands at present almost, or entirely, waste a valuable property; Richmond Park offering an excellent opportunity for experiment, as it is only one mile from the river at Mortlake, and the soil is dry, sandy, and therefore the very best for the purpose. A Company even might be founded on the scheme; and as a commencement, the farming of Bagshot Heath would be a certain profitable speculation. That part of the Heath in the neighbourhood of Hartford Bridge Flats, or any similar ground near the railways or canals is peculiarly available; and being secured by lease or otherwise, a small receptacle should be formed at the end of the Effra, Great Duffield, King's Scholar's Pond, Ranelagh, or other great sewers, and pipes laid on to a large receptacle in the middle of the Heath, from which they might branch to smaller receptacles. A separate receptacle for Mortlake and Barnes would save the necessity of employing large pipes, or other means of conveyance. Calculation and circumstances would, however, show which would be the cheapest and preferable mode of conveying the manure; for short distances the pipe system is decidedly best, but canals and railways appear better adapted to supply beyond twenty miles. This in the hands of proper managers would be a most successful Company, for it would require little capital to farm the Heath, and to cultivate it by the aid of manure, which can be had for nothing, as it is now allowed to run to waste; and the returns would obviously be great.

Causes of altering the original plan.

One of the causes of my altering my original plan for erecting a line of quay raised on pillars, with the sewer passing underneath, was the change I anticipated in the river from the removal of Old London Bridge, which I believe to have been originally intended to serve the double

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purpose of bridge and back water; the result has fully justified my expectations, for the water is so low at ebb tide as to expose a large portion of the bed of the river, the exhalations from which are and will be so prejudicial to the health of the metropolis, that the consequences are melancholy to contemplate: the bridges will materially suffer from the increased rapidity of the stream, which is gradually undermining the piers, and wearing the bed of the river; and the injury done to the traffic will be immense. To still further improve the river by rendering the depth at low water uniform, and preserving the bottom from unequal wear, I propose to construct *sub-weirs* across the river from shore to shore, by means of piles, with beams pinned down upon them: about one hundred feet of the middle being three or four feet lower than the rest of weir, which should be made to slope to the shore till it meets mean low water mark, (see plan.) By placing the weirs at distances of a quarter of a mile, the fall would be gradually and regularly distributed from Westminster to London Bridge, thus the shores being parallel and the bed levelled the wear would be permanently equal, as must be obvious, for whatever rise there may be in the bed of a river acts as a sort of weir round which the water rushes, scouring and causing deep holes, which obstruct the navigation and render it dangerous. As relates to the mode of working without coffer dams where the waters are deep, by employing cast iron planking, grooved piles made of wood and iron, (see plan) should be driven into the shore at determined distances, and connected by beams from pile to pile, forming equilateral triangles; the piles being thus firmly fixed, the planks should be raised and slid into the grooves, the water being allowed to play around, until a sufficient distance be completed to admit of closing in, and backing with concrete or

Sub weir to equalize the bed of the river.

Mode of working without coffer-dams.

Iron or slate planking.

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other material. As the substratum of the shore for a considerable portion of the line is of a soft yielding nature, wherever there is any heavy super-structure to be raised, the ordinary method of foundation by piling is a mere waste of labour and material, and Mr. C. Fowler, the able architect, therefore, found it necessary to employ other means in his works at Hungerford Market. I propose to treat this soft earth as I would a semi-fluid, thus—to form a description of raft fifty feet each way, with sides to keep out the water all round, and that this should be rendered water tight by being lined with pitch or asphalte, which should be covered all over with one layer of concrete about three feet deep; the next of the same size should then be made, and so on in succession, the whole, when completed, forming one great raft effectual even on a quick sand, and so dry, firm, and broad a foundation, that a superstructure of any magnitude might be raised upon it.

Foundation without piles where the substratum is soft.

As I do not consider the principal merit of the above plan to consist merely in the embankment, and in preserving the river from pollution, but in saving the manure, which is of the most valuable quality, it is requisite to add some information corroborative of the principle of saving the manure, which has been so ably advocated in the "Gardeners' Magazine." The means employed in Flanders and in France for collecting the fertilizing products which compose it, both in a desiccated and in a fluid state, are fully detailed in the "Journal des Connaissances Usuelles;" and from the accounts there given by experienced agriculturists, it appears that the extraordinary fertility which results is not equalled by any known manure. It is obvious, therefore, that this would prove a mine of wealth if properly regulated; and as the demand would be immediate and increasing, it would be highly advan-

Principle of saving the manure urged in the "Gardeners' Magazine."

Journal des Connaissances Usuelles.

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tageous to any persons who would speculate in forming a Company, or Companies, for farming the manure; as the farmers, instead of procuring at great expense the rubbish they are now necessitated to use, would at once proceed to the readiest, best, and most plentiful supply, consequently the returns would be great and without delay.

Mistaken idea that the sewage is substantial.

A mistaken idea seems to have been adopted by some, that the sewage is substantial; the quantity of water which enters, and the tendency of fermentation to liquify these substances, which would otherwise choke the drains, having escaped consideration. That such fluid material is

Unfit for making poudrette.

unfit for making poudrette must be apparent; and I have, therefore, firmly opposed it, for exclusive of the expense and delay, the operation of settling, straining, evaporating, and drying, would form a most dangerous nuisance,

Advantage of the sewage being liquid.

that too in the very heart of London. Now, in point of fact, the fluidity of the sewage constitutes the chief advantage of my plan, for it is not only ready for use without the least preparation, but it is ascertained, from the highest agricultural authorities, that the liquid manure is

Nitrogen the source of fertility

more valuable than any other, as it possesses far more nitrogen, which chemical science has proved to be the

Quarterly Review notice of Liebig's Organic Chemistry, Vol. 60, No. 138.

most effective source of fertility. The Quarterly Review, (No. 138,) aptly observes, that "when we reflect on the vast importance of nitrogen as an ingredient of grain, and on the fact that cow and horse dung contain very little of that element, we must see how essential it is not to waste any portion of liquid manure, the proper source of that portion of nitrogen which must be added to what is derived from the atmosphere before we can obtain rich crops of grain. But a still more important source of nitrogen is in the contents of our common sewers, which, from a barbarous ignorance, are commonly thrown into the sea;"

Liebig.

and Liebig himself says, that "when considered that with

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every pound of ammonia which evaporates, a loss of 60lbs. of corn is sustained, the indifference with which these matters are regarded is quite incomprehensible." It is but necessary for me further to refer to, or quote from, some of the authorities from whence I derived most important information on this subject, to make it evident, that even poudrette is of no value, and will not act without rain, or artificial irrigation. All the experiments of Sir Humphrey Davy, Sinclair, and others, tend to prove that fertilizers must be applied to the roots of plants in a fluid state, as the nourishment is immediately absorbed by the extremities; even water alone is found to be an admirable manure, acting as Lord Bacon says, "not only by supplying useful moisture to the grass, but likewise carrying nourishment dissolved in the water;" it is, therefore, more powerful in proportion to its impurity, flood water being the most valuable of any, as we learn from Lord Western, who strongly animadverts on the shameful neglect of our agriculturists of the uses of even water, and whose information on this point, founded on his own experiments and observations on the continent, is most important and interesting. The necessity of rendering the manure very liquid is admirably pointed out by Mr. Robertson, Mr. Knight, and the Gardener's Magazine, in its extracts from the Bulletin de la Société de Genéve. The Flemish use the manure in a fluid state, as being more active, applying it the first year to the growth of hemp and flax, and the second for the cultivation of the best class of grain: its action is stated to be very powerful, extending its influence over the soil for many years. Sir George Staunton likewise tells us, that "the Chinese construct large cisterns free from absorption, to contain besides the manure and soil of every kind, all sorts of vegetable matter, as leaves or roots, or stems of plants; with all these they

Sir H. Davy, Sinclair, &c.

Lord Bacon.

Lord Western.

Mr. Robertson, Mr. Knight, Gardener's Mag. Bull de la Soc. de Geneve.

Sir G. Staunton as to the usage of the Chinese.

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mix as much animal water as can be collected, or common water, to dilute the whole; and in this state, generally in the act of putrid fermentation, apply it to the ploughed or broken earth. And Professor Liebig in his profound and admirable "Organic Chemistry, in its application to agriculture and physiology," after forcibly showing the sources of fertility in soils, and dwelling on the employment of fluid animal manure, says,—"How infinitely inferior is the agriculture of Europe to that of China! The latter is the most perfect in the world; and there where the climate in the most fertile districts differs little from the European, very little value is attached to the (solid) excrements of animals." That the use of fluid manure was well understood by the ancients cannot be doubted; and in later times Evelyn gives some most interesting particulars regarding its aid and value. Does it not then show incredible ignorance, that a country boasting itself second to none, should not merely cast away its real wealth, namely, the means of producing that which is actually useful and necessary, but that in doing so, it should cause an additional waste, by rendering a great part of the water of the metropolis unfit for use? and should we persist longer in such barbarism, especially after such information as the following, of the entire success attending the recent application of the town drainage near Edinburgh? Mr. Thomas Oliver has stated to a committee of gentlemen, who reported on this plan, in 1835, "From the elevated position of Edinburgh there is a considerable extent of ground which can be overflowed by the water from the city drains in its progress to the sea; and of late years it has become an object of attention to the proprietors and occupiers of ground so situated as to admit of its application; there are, I should think not less than three hundred imperial acres to which it is regularly applied, and with great advantage." Such ground is annu-

Professor Liebig. Organic Chemistry.

Evelyn.

Mr. T. Oliver upon the drainage near Edinburgh.

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ally kept in grass, and yields from three to six cuttings in the season, which let to dairymen and others, at rents varying according to circumstances, from £12 to £24 per acre. We perceive from this statement, that the chief benefit derived from the drainage of Edinburgh arises from the fluid part; and if we reckon the increased yearly value of the land above mentioned at £10 an acre (which is under the mark,) it yields a clear revenue of £3000 per annum to the proprietors of those grounds through which the drains pass. Mr. Stephens also states, that the whole of the Freegate Whins is composed of nothing but sands, deposited by the action of the waves of the sea. One hundred and ten meadows belonging to Mr. Miller gave a clear profit of £2,010 in 1827; and the annual expense of keeping them in repair is from 10s. to 15s. an acre. In 1826 part of the Earl of Moray's meadow fetched £57 an acre; the land, however, usually lets at from £20 to £30 an acre. In detailing these facts the northern situation of Edinburgh, which is the same latitude as St. Petersburgh, must be considered; for further south, where the temperature is warmer, the produce would be superior. I could go on multiplying authorities, if requisite, but such evidence as I have already adduced is sufficient to show the necessity of putting some plan into execution that will, at the same time that it saves the manure, correct the drainage of the towns, &c.; for it is quite impossible that the old and primitive system, containing so many abuses and not one advantage, should be any longer maintained.

Mr. Stephens, Freegate Whins.

For the unwholesome state of the water, owing to the sewage, I beg to refer to the following extracts from the evidence before the Committee of the House of Commons, upon Metropolis Water Supply, 1828, and to the whole of that evidence, which most strongly proves the necessity of effecting a remedy.

Evidence as to the state of the water.

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Mr. Beare. From Mr. Beare's statement:—" A slender portion of common sense, however, authorizes me to affirm, that a stream which receives the daily evacuations of a million of human beings, of many thousand animals, with all the filth and refuse of the various offensive manufactories, which of necessity must be carried on in one of the most populous cities of Europe, cannot require to be analysed except by a lunatic, to determine whether it ought to be pumped up as a beverage for the inhabitants of the metropolis of the British Empire; the question which you will decide, is not whether a few grains of this immeasurable filth can by chemical process be extracted from a bottle of water taken here and there, and subjected to the process of a tea-kettle elaboratory, but whether, without any process at all, this stream, palpably known to contain all this mass of filth, should continue to be supplied."

Mr. Goldham. From the evidence of Mr. Goldham:—" I was yeoman of the market (Billingsgate) 25 years ago, and at that time there were 400 fishermen, each having a boat and a boy fishing above and below bridge, and now there are not 200 men engaged in this fishing, and many of them are selling off their nets and boats."

Mr. Lambe. From the statement of Mr. W. Lambe:—" It is the putrescent matter which is the most obnoxious principle of common water; it is a matter of common experience that water according to its different qualities, affects the stomach with a peculiar feeling which we call weight."

Mr. J. Wright. From Mr. J. Wright's Memoirs:—" So far back as the year 1535, an Act was passed in the reign of Henry the Eighth, in which it was enacted, " That if any person or persons do, or procure any thing to be done, in the annoying of the stream of the river Thames, by casting of dung,

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or rubbish, or other thing in the said river, he shall forfeit for so offending 100s.:" but this was not considered enough; "if any person or persons in great rains sweep their soilage or filth of their houses into the channels, and the same afterwards is conveyed into the Thames, every person so offending will forfeit for every such offence 1s. 8d."

For further information see the Reports of the Commissioners appointed by His Majesty to enquire into the state of the supply of water in the Metropolis, dated 21st April, 1828; particularly the evidence of Mr. C. Mylne, Dr. Paris, Dr. Harrison, Dr. J. Johnson, Dr Kerrison, Dr. Yates, Drs. Somerville, Hooper, Hoffman, W. Lambe, Messrs. Armstrong, Brodie, J. Luckie; also to Mr. Ainger's plan, in which he most forcibly points out the horrible state of the river, and need for alteration. Regarding the embanking and forming quays, the proposition has been so often and so powerfully urged in Parliament and elsewhere, that it requires no further remark from me; for I could but recapitulate what has already been so admirably advanced as to the numerous consequent advantages; I shall, therefore, content myself with referring to the Reports of the Committee for Improving the Navigation of the River Thames, presented to the Court of Common Council, 3rd August, 1832, and January, 1842, which contain much useful information upon the subject.

Having now explained my plan and its advantages in all its principal details, the only questions that remain for consideration are the expense and returns, though these ought not to be the questions in a scheme possessing so many important results, and which would give employment to so many hands; if, however, all other advantages are to be considered subservient to the cheapest method of preserving the sewage from entering the Thames, I would

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suggest the taking from the river wherever it is too wide or there is no obstruction, making the main sewer pass before, behind, or under the wharfs, quay, or docks, in order to avoid compensation for what would be in reality an improvement; setting aside, as secondary, the objects of quays, improved wharfs, &c. It would be less labour and expense to keep the line of the intercepting sewers behind the embankment, as *close as practicable to the old quay*, even using it where suitable, than to continue each drain separately into the river, as the length of sewers from the face of the old quay to that of the new quay, from Westminster Bridge to Waterloo Bridge, when added together, would be nearly two thirds longer than the line of the intercepting sewer, which would receive each drain in its course, with only one mouth instead of seventeen, and each individual portion, before described, could besides be made in size proportionate to the number and dimensions of sewers entering it, that from Waterloo to Blackfriars being small compared with that from Westminster to Waterloo, but that from Blackfriars to Southwark necessarily larger, as it would receive the Fleet sewer. There is one point which I have ever earnestly urged,—the necessity of selecting *one line* for the embankment, and never *allowing it in any way* to be departed from in future buildings, or works upon the shore; and I am proud to say that this important point has at length been taken up in the City, and strongly recommended in the Report recently presented to the Common Council. In marking the line of embankment on the north shore, that which is apparently pointed out, is the same as I originally laid down, and subsequently published in Report of House of Commons on Metropolis Improvements, 1839. In proposing to execute this work by portions, such portion or portions should be adopted as accord with the means at command, leaving the work so executed that it might be taken up and carried on to any desired extent: for example, from the

Cheapest mode of effecting the objects of the plan.

Executed in portions.

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Houses of Parliament to the Tower, making both banks parallel of course; or if this should require larger funds than could be obtained, then from the Houses of Parliament to Waterloo, Blackfriars, or Southwark Bridges, dividing the portion chosen into three parts, and again subdividing these into various sections; the whole to be conducted by resident engineers, and officers, under the control of one leader, in connection with a committee of competent men, appointed for the purpose. It might thus, with sufficient funds, be completed in two years, or even less, by employing additional men, and it would be advisable to complete it speedily, for the returns would be immediate.

I will here recommend Hague's Vacuum Engine for raising the sewage, and even propose its adoption as a means of return. It appears that 3000 horse power are used on both sides of the river, in place of which vacuum engines might readily be substituted, as this power is simple, efficacious, and transferable at any distance. The mint works at Utrecht and at Rio Janeiro are carried on by it, and an imperfect application of it is used in our own Mint. Mr. Foster of Stourbridge, Messrs Brown of Manchester, and several large houses in the City use this power; and at Horneback in Cornwall there is one placed 400 fathom from the primary power. "The present improved system of it is due to that ingenious and experienced engineer John Hague, who some years since drained the district of Littleport and Downham, which had been pronounced irreclaimable, and if it could be hired, people would gladly take it in preference to steam power; and by creating, and letting it out in different parts of the works, on the banks of the Thames, we should lessen the volumes of smoke which now cross the river, and pass over London, whilst we afford an additional source of revenue." (See Report of Committee of Gentlemen on my Thames Improvement Plan, 1835.)

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As the early part of this plan was principally devoted to the method of preserving the manure from waste, I will in conclusion observe, that if adopted throughout the kingdom, it would enable the country to be maintained in a complete and most fertile state of cultivation, at all times equal to the population, for all the waste and unproductive lands in the hands of government, and ground recoverable from the sea, marshy banks of rivers, or where rivers have more width and less depth than are requisite, should be attached to the system. Until some such general and uniform plan is adopted, we can never justly complain of want of employment for the poor, occasion for emigration, or use for poor houses, excepting for the infirm, when their occupation would be no degradation; and how long would it be before we should be obliged to resort to such measures, when so vast an extent of land is still in a state of savage barrenness, and even that which is cultivated, has not half the labor bestowed upon it which is necessary for its utmost produce.

Before finally concluding the second division of this plan I will offer a few remarks, in some degree called for, by the recent publication of the "Report of the Court of Common Council, from the Thames Navigation Committee." In this report Mr. Walker objects to my plan, on the ground that it interferes with the coal trade and wharfs, overlooking the fact that the intercepting sewer passes behind the wharfs and docks, possessing the advantage of one short line of sewer close to the old shore, instead of carrying every individual sewer across the recovered ground to the face of the new embankment, a distance of 400 feet: and another fact, the executing the work in portions, with small cesepools at certain points, and facilities for removing the sewage, has entirely escaped his observation. Mr. Walker likewise erroneously states my public walk to be a raised

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terrace, which could not extend below London Bridge. Now, *I do not use a terrace in any part of the line* excepting to pass certain wharfs *between Blackfriars and London Bridges and the Tower*, where the walk is raised upon pillars, when instead of interrupting business, and interfering with the wharfs, a dry roof equal to a good warehouse would be afforded; the public walk moreover is not a necessary part of my sewer, but is merely an advantageous addition, serving to connect the bridges by a continuous line of communication along the banks of the river from the west to the east of London. Mr. Walker indeed so far approves my line of embankment as to place his almost exactly upon it, and advocates the plan for the Surrey side of the river, though he does not allude to my publication containing it; he purposes however casting the sewage into the river instead of preserving it. Mr. Walker admits that I was the first to propose preserving the river from pollution, but recommends "as *more practicable*" Mr. Cubitt's plan of diverting the sewage, to carry it north of London from the extreme west to the River Lea, where it is to be discharged and poison the air, but without any view of preserving the manure. Now as the main sewers run *down* to the River Thames with considerable fall, and Mr. C. only intercepts the *heads* of these sewers, he would but take up the flood drainage, which now serves to scour them, and cannot be dispensed with, unless indeed he is enabled to make the sewage flow up-hill.

In so far departing from my usual course as to notice Mr. Walker's misconceptions regarding my Thames Improvement Plan, it is scarcely out of place to allude to the supposition and statement of many, that I have abandoned my original plan altogether. The error is entirely unfounded, for I have never abandoned any one point, excepting carrying the railway along with the public walk,

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because it would not work well with the bridges; but it has doubtless arisen from my showing a variety of ways of effecting the same objects, each change being to obviate objections which had been advanced; but from first to last, *the great principle* has remained unchanged. Having with immense labor and trouble obtained all the necessary information in furtherance of my views, so far succeeded as to satisfy those who were before sceptical, and awakened a strong feeling in favor of the objects, it does not certainly seem probable that I should abandon my plan at the anticipated point of success; on the contrary, I am pursuing my aim with renewed perseverance, and shall continue to do so to the last, in the firm belief that the public will ultimately assist in carrying out such important measures.

Without further observation I will enter upon the description of that portion of this plan which refers to the River Thames below London Bridge.

THIRD DIVISION.

Plan for Improving the Navigation and Banks of the River Thames below London Bridge, and for connecting the Inland Railways with the London and Foreign Ports.

Objects.

The objects and advantages of the following plan are, first, to form a short, free, and unimpeded passage to the Pool of London for all nations of the world.—Secondly, to create magnificent Docks on each side of the river, each two miles and a half in length and a quarter of a mile in width.—Thirdly, to obviate accidents by loss of life, and and injury to the shipping from the over-crowded state of the River.—Fourthly, the formation of public, private, or market gardens, by the improved drainage to those lands on the line, at present of little or no value.—Fifthly, the drain-

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age of Tilbury Marsh, and improvement of the banks of the river, added to which are, the soft nature of the ground, which is likewise so low behind the embankment, that the cutting and whole work might be accomplished in one year, that there are no buildings to be pulled down on the line, that the river itself will be the means of facilitating the work, by lessening the expense of conveying material; and lastly, that *useful work* would be permanently afforded to an immense number of the unemployed poor.

Too little fall in the Thames from London to Greenwich.

The river Thames from London to below Greenwich has so little fall, that the Pool, and all that part where the Docks are situated, have become the foul receptacle of the filthy drainage of London, which settles and chokes the bed of the river, the docks, and their entrances; the operation being, that upon the flow of the tide it meets the downward current of the stream, disturbing the bed, and rendering the waters, which when at the highest enter the docks and all inlets and recesses, thick and muddy; the stillness of the water, at the turn of the tide allowing a gradual deposit which would eventually fill up to the level of high water mark, nature thus forming her own embankments. To provide against this, constant expense and labour are required, and to such an extent that Mr. Tomlins of St. Catherine's Docks stated to me, that it cost the company annually £1000 to cleanse their dock; and I have since learnt, that it will require an additional £1000 per annum to keep the entrance clear. Sir John Rennie likewise informed me, that it had cost £2000 per annum to keep the West India Dock and entrance clear, but means have been since adopted somewhat less expensive. Now if such sums are annually expended on these two docks alone, it follows that there must be a similar expenditure in proportion to the size, at the other docks; and I do not, therefore, think I am over calculating in supposing that £20,000 per an-

De la Beche.

St. Catharine's Dock Company pay £1000 per ann. to cleanse the dock: and the West-India Dock Company nearly £2000 for the same purpose

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num is expended in cleansing the docks, and dredging the river.

Means of remedying the evil.

I am satisfied that no other efficient remedy for this great evil has as yet been offered than my principle of drainage, improving the banks of the river, and of fixing floating piers: and as it becomes daily more evident that the evil is increasing from the formation of fresh drains, consequent upon the apparently interminable augmentation of buildings around London, and the accompanying increase of trade and traffic, it demands the interference of the merchants to terminate a system which injures the health and navigation of the river, and, likewise, of the landholder to preserve from waste that manure which belongs naturally to the soil, and not to the water,—as it affects the interests of, and in course of time, will ruin both. To remove the defects of want of fall or current, and also of space in the Pool, I propose to form a cut across

Cut across the Isle of Dogs.

the Isle of Dogs from Limehouse to Folly House, and again across over Brickfield to Woolwich Reach, as this straight line from Limehouse to Woolwich would shorten the distance two miles, thereby increasing the current and enabling the river to sweep its own way to the sea without requiring the use of the dredging machines which, at present, continually block the already over-crowded Pool. The cut should be about 400 feet wide, the same width

Width of the cut 400 feet, and depth 12 feet.

as the water way in the Pool, which should be maintained uniform by means of floating piers, the vessels being invariably moored *within* the docks thus formed, and never allowed to lie in the channel; (see plan)—and the depth should be the mean depth of the river at Limehouse Reach (according to the soundings) 12 feet being some-

To maintain the depth of the cut, sub-weirs to be placed at the entrances.

what less deep than at the turns. In order to preserve the depth of the cut and prevent its wearing; and that the river itself should still continue to run in its own

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channel, sub- weirs, previously described, should be placed at each entrance—that at Limehouse Reach to be one foot higher than the one across the River, as this would yet further maintain the present course of the stream: the river in its natural channel being used as extensive docks, from which the railways on each shore could convey the merchandise; and the old docks could be converted into dry docks, their localities being well suited to the purpose. The great interior railways should meet at one central terminus, and be thence connected with the docks—the depôt for the South uniting the South Western, South Eastern, and Brighton ways, should be at the Obelisk, a spot equi-distant from all the principal bridges and great thoroughfares, thus facilitating the communication of the extremities of the country with foreign ports; but the warehouses for coals and merchandise for the use and consumption of London and its vicinity, should be on the north side where the River Lea enters the Thames, and united with depôts at the London Termini of the North Eastern Counties, Birmingham, and Great Western Railways, by one general connecting railway; (see plan)* an improvement becoming daily more necessary to relieve the lower and most crowded parts of London of the constant traffic of carts and waggons, which crush and wear the road from the great weight, continually block the thoroughfares, impede business, and endanger lives; and well deserving the attention of the Metropolitan Improvement Society: there is besides ample room for a dock out of the way of the proposed alterations, with deep water for vessels of burthen, and by forming the harbour of the floating piers it would never choke nor want cleansing: a new outlet could also be made for the River Lea, improving the navi-

To form docks of the river in its natural channel, and use the present docks as dry docks.

Railways to the interior to meet at one central Terminus.

* It must be understood that the lines laid down are according to the present maps, subject, of course, to such alterations as a more accurate survey may requrre: thus, where I have drawn straight lines to given points, my intention is to keep as near to the straight line, and to sweep as easy curves as the localities will allow.

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gation of both rivers, and affording additional recovered ground.

A floating harbour on the plan I have described would be of great, indeed paramount advantage to Brighton, from the absolute want of a protective harbour on this coast, Shoreham being inefficient, and impossible to enter at all times; even this spring one vessel, and last season two, were lost off Brighton, from the absence of a place of refuge, and the cost of those vessels and cargoes alone, would more than have paid the expense of forming it. A harbour at Brighton would be otherwise important by at once connecting the opposite ports of France by means of the Brighton Railway, with the depôt at the Obelisk, thus bringing France nearer to London, and promising proportionate success as a speculation.

Saving of distance and time, and increased space, equivalent to four miles of distance.

The saving of distance and time from the shortened line and increased current in the river conjoined; with the additional room, which would allow vessels to pass and repass at all times at their utmost speed, taken together may fairly be considered equivalent to four miles of distance, and distance being time, and time and labour the principal property we have, I would show that, granting 1000 ships, steamers, and boats of every description to pass and repass this point in one day, there would be 365,000 per annum, which multiplied by 4 would be

1,480,000

equal to a saving of one million, four hundred, and eighty thousand miles in the course of the year; if the number of vessels were fewer or greater, of course the decrease or increase would be proportionate; I therefore, conclude that the saving of time, and expense in the wear and tear of vessels, and the employment of men, would themselves

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pay for effecting the object. Obvious as must to many have been the advantage of forming a channel across these two peninsulas, the execution of such a project can only have hitherto been prevented by the want of some feasible plan, or from the absence of pressing necessity. It is not for me to say how my plan should be regarded, though I can venture to express my own conviction of the line I have marked out, and mode of execution being the best for the end in view: but I may be allowed to urge that the present is the time for some such work, when our river, the great highway to the Metropolis is crowded by ships of all nations, when our own native traffic is almost endlessly increasing from the use of steam, and when masses of our people are totally unemployed, and therefore factious and discontented.

The present the fitting time for this work.

In conclusion it must be evident that the land at the Isle of Dogs and Bugsby Marshes would be greatly improved by the drainage consequent upon the cut, I propose therefore to drain it yet further, and the soil being very rich, to form Botanical, Public, Tea, or Market Gardens, which would be in every way productive and beneficial. A naval column, surmounted by a magnificent light, might be erected in the garden in the Isle of Dogs, facing Greenwich Hospital, serving the double purpose of a monument to the brave seaman, and of lighting the whole harbour on the south side. A similar tower should be erected in the lower peninsula to the memory of the naval commanders, and illumining the harbour on the north. These monuments so situated in composition with the Hospital, would be both ornamental and useful, presenting a most magnificent view from the heights in Greenwich Park, rendering the whole a grand work, and proud sight to every British sailor who enters the port. A road planted on each side should run parallel with the channel

Conclusion.

Isle of Dogs, and over Brickfield improved by the drainage.

To form Gardens

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and river from Greenwich to Woolwich, and mansions and villas could be erected at all available points on the ground recovered by the embankment, under such restrictions as might be necessary to prevent encroachment of rights of way or approach to the river, and thus rendering ready and ample means of return for the outlay. As regards the drainage of Tilbury Marsh and further embankment of the river, I refer to the plans published in 1829 and 1832, as worthy of serious after consideration though not necessarily belonging to this plan.

Embanking and draining Tilbury Marsh.

Embankment of the river.

In completing this general plan for the *Improvement of the Thames*, I contend, that, if it were put into practice in its entire state, that exclusive of the saving in the present expenditure which would be effected, a great revenue would be obtained. First, from the unfailing supply of pure water without engine or reservoir. Secondly, from the sale of engines, and value of land recovered from reservoirs, &c. besides the great power for working water wheels, afforded by the whole weight of the Thames falling over the weir at a height of 10 feet for nine hours running down, which valuable primary power might be let out to work vacuum or other engines. Thirdly, from a toll at the *weir*, as the navigation would be rendered constant, and so prevent loss of time in waiting for the tide. Fourthly, from the preservation of the sewage for agricultural purposes. And lastly, from the rate on vessels passing through the line at the Isle of Dogs, and for using the grand docks on each side of the river. Obviously an immense revenue would be raised in this way without being viewed as a tax, the full value and ample benefit being given in return for the money paid, rendering the river a most valuable property.

Sources of revenue.

I take leave here to avail myself of Capt. BULLOCK'S most able observations and notes, printed in the Report of

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the Navigation Committee presented to the Court of Common Council, January 1842, as I feel proud to say that his remarks in every way coincide with the views I have endeavoured to promulgate and work out.

CAPTAIN BULLOCK'S OBSERVATIONS.

Enquiries having been instituted by the Corporation of the City of London, respecting the practicability and expediency of an uniform embankment of the Thames throughout its course, it has been referred to me to consider and report on the effects likely to be produced by such a measure on the bed of the river.

Previous to my answering the questions submitted to me, it seems desirable that I should state what I conceive to be the natural laws regulating the movements of a river, and the formation of its bed, so far as such laws are involved in the subject under consideration.

A current of water obeys the general law of motion, and continues its course in a straight line until it meets with some obstacle which forces it to turn aside; hence, at every bend in the channel of a river, the current runs in on the concave side, and presses on the bank.

The velocity of a stream, under like circumstances of a declivity and pressure, depends on its freedom, or, in other words, on its breadth and depth. In any given section of a river the greatest rapidity of a stream will, generally speaking, be found in the deepest part. Where there is a shoal on the side of an active current, the contact of the rapid stream with the retarded and sluggish water on the shoal will have the effect of producing a circular motion, or eddy, in the latter, the extent of which will be regulated by the extent of the shallows. What is here said of shallow water is true of any sluggish water, however deep, which, protected by the irregularities of the banks, adjoins an active current.

Every back-water is attended with one or more eddies,

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in the centre of which are deposited the particles of sand and mud which were supported and carried along by the water while it had a rapid progressive motion; a bank or shoal is thus formed.

Every bank or shoal in the bed of a river is itself a determining cause of a back-water, and consequently tends to create another bank lower down the stream. The increase of shoals in any one place must there modify the direction of the current, the effect of which modification will be felt lower down; so that the disturbance created by any local interruption in the water-way is sure to be propagated down the stream, imperceptibly, perhaps, in the first instance; but it can hardly be doubted that, in the course of years, very great deformities in the bed of a river may arise from very slight and apparently unimportant first causes.

It needs hardly to be observed that what has here been said of banks and shoals naturally formed applies still more forcibly to all constructions, such as piers, jetties, wharfs, &c., which encroach on the water-way; and the worst effects of which are often not imputed to them because produced at a distance. A change in these constructions, or the increase of them, may give, more or less, a new direction to the stream; may impel it to plough up new channels, to disturb, divide, and probably, in some measure, to clog the navigable water way.

In tidal rivers, where there is a current alternately up and down, it may happen that the ascending and descending currents do not take exactly the same channels; their agencies are, consequently, at variance, thereby increasing the disturbance in the bed of the river, the wear and tear of the banks, with other evils.

These principles being established, we may now proceed to consider the question whether it be possible to devise a channel for a river, so constituted as to secure the two conditions of clearness from all obstruction, and permanence; or, in other words, whether, by embankments judiciously constructed with respect to width and form,

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a river may not be directed in such a manner that its currents both ways will harmonize with the general windings of the course, and whether it may not be freed from all tendency to form shoals and to shift its channels.

It appears to me that these desirable ends may be easily attained by embankment. A river's bed is spoiled by the too great diffusion of the stream, by the wear and tear of the banks, and by obstructions of one kind or another created in the water-way, from all which ensue diversions of the current and a tendency in the river to change its course, throwing up banks and shoals which, more or less, impede the navigation.

Now these causes of deterioration may be completely removed by embankments, reducing the bed of a river to a sufficient water-way, and nothing more, and presenting to the pressure of the stream, at the bends of the river, a solid unchangeable front, of such a form as will guide the current both ways in one channel: if to these embankments be superadded some regulations calculated to preserve inviolate the principles on which the embankments are formed, and to prevent all projections and obstructions in the water-way, it cannot be doubted that the river will gradually work itself a free, uniform, and unimpeded channel; and, having thus improved its course, that it will have no tendency to change it. The same natural agencies which, left to themselves, continually change their direction and plough up different channels in a stream, will, if fixed in their direction and rid of variable and undue hindrances, be converted into the improvers and preservers of the same stream.

It is easy to apply to the Thames what has been already said of rivers in general; but it must not be overlooked that an additional argument for the proposed embankment may be found in the circumstance that the Thames is rather wider above bridge than in the pool; for the contraction of the stream above bridge will probably have the effect of equalizing the current and giving it an equable movement. And, moreover, the single fact that the pool is in general

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narrower than the river above bridge is of itself sufficient to show that the latter is wider than necessary.

It would be advisable perhaps, to expedite by dredging the process of clearing and deepening the bed of the embanked river, instead of leaving it to the comparatively slow operation of natural agencies; but in that case it would be necessary to adopt a better system of dredging than that pursued at present; and, instead of making deep holes in the channels, the dredging machine ought to be employed solely in removing shoals. And, in general, it may be remarked that the mischiefs arising from the neglect of the river's bed or banks, or from injurious interference with them, cost much more for their repair or correction than would suffice to maintain a vigilant superintendence competent to prevent them.

The Thames, though for ages the greatest commercial river in the world, has hitherto been excluded from its due share in the improvement going on around it. In our own times the navigator has received incalcuable benefits from science; and, as might be expected from the maritime genius of this country, the chief glory of these scientific labours belongs to ourselves. Nearly all the shores of the known world have been surveyed by British officers; the coasts of our own isles, and the seas around them, have been examined with a patience and an accuracy that will leave nothing to desire for ages to come; nor has the present hydrographer of the Admiralty overlooked the Thames, and, in consequence, it has been lately surveyed with the utmost care and minuteness by the direction of the lords of the Admiralty, but *without reference* to the *embanking of its sides.* Amidst all this activity, originating in the spirit of the age, and called for by its wants, it is not surprising that the Corporation of the City of London, actuated by the same spirit, should have directed their attention to the improvement of its banks on a scale commensurate with the advancement of science, and suitable to the vast resources of the most wealthy, civilized, and enterprising city in the world.

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The extension of some care to this object is also imperatively called for by the recent change in the mode of plying on the river, arising from the great increase of small steamers. Many thousands of persons are now occasionally carried up and down the river between bridges in the course of a single day. The navigable water-way has thus acquired a new value; and, while it has grown more desirable to increase as far as possible the available channel, it has also become more necessary to prevent the endless multiplication of piers and jetties which now disfigure and threaten ultimately to affect injuriously the navigation of the river.

In conclusion, I strongly recommend the projected embankment, as a certain means of effecting a great and permanent improvement in the Thames; it would, if fully carried out and maintained with suitable regulations, have the effect of equalizing the current and bed of the river, removing shoals, and increasing the navigable water-way. Owing to the numerous obstructions in the river, with the interrupted and oblique currents attendant on them, as well as the constant wave from the steam-boats which washes the banks, there is a larger quantity of mud kept in a state of perpetual oscillation than formerly, but this will be remedied by unity of channel; and, with an unembarrassed water-way, the stream thus loaded with sedimentary matter will pass onward towards the sea into deep water. The great extent of the mud banks, which now exhale offensive effluvia at low water, would also thereby be much diminished; the stream, being made deeper and stronger by its embankment, would more effectually perform its cleansing office; and these benefits, independent of that of considerably increased facility of navigation, now grown so important, seem to me sufficient of themselves to incite to far more arduous and expensive undertakings than that of merely embanking the river near the metropolis.

To the Corporation of the City of London belongs the honourable privilege of carrying into execution the improvements here discussed,—improvements which, whether con-

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sidered in respect to utility or ornament, are well worthy of the energies of a great commercial nation.

FRED. BULLOCK, Captain, R. N.

DESULTORY NOTES.

It is universally admitted that the navigation of the Thames has long been subjected to inconvenience from the crowded state of the shipping which at times throng the river, and that it is still frequently and seriously interrupted, from a variety of causes, in defiance of law and the regulations which it has hitherto been found expedient to prescribe, as well as of the earnest endeavours and vigilance of the harbour-masters.

The interest which the Corporation of the City of London has in the prosperity of the trade of the metropolis renders it imperative that, in order to secure to the public a clear and unembarrassed water-way, and thus establish a free intercourse with the fountain of commerce, every cause of impediment, however remote, extraneous, or artificial, should be investigated and, as soon as possible, removed.

Some of these obstructions proceed from original shoals, which have doubtless operated in giving the bed of the river its present form, and are growing causes of impediments to the navigation of a river. This subject well deserves the consideration of the Corporation; for, whatever may be the difference in opinion as to the ways or means to be employed in removing shoals which obstruct the navigation of the Thames, it is certain that some such means ought *immediately* to be devised, that the transit of ships be no longer delayed for want of water to carry them to their final destination—the docks.

An instance of the facility of deepening and preserving an uniform depth, as well as the advantages resulting from the operation, may be seen at the entrance of the *St. Ka-*

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tharine's dock, where there is now at low water, off the principal buoy, 20 feet, shallowing gradually to 8 feet at the wharf; but as similar advantages are contemplated in the general embankment of the Thames before referred to, it is needless to dilate upon the subject.

The lower pool is occasionally in a confused state, and is at those times extremely dangerous, when the water-way is contracted by the tiers of colliers, even when the lawful space of 300 feet is preserved; but I contend that it is not sufficient to yield to the public the mere *possibility* of navigating a crowded river; the *certainty*, as far as human means will allow, ought also to be secured to them. Circumstances frequently arise to prove that the 300 feet is not sufficient for the purpose of a safe navigation, as well as to show that a little timely assistance at that *narrowed part of the river*, would prevent many serious accidents; positive means, and the facility of using them, ought therefore to be provided and at hand, the expense of such aid being defrayed by the vessel requiring it; for whatever produces danger, difficulty, or delay in the transit of the Thames, cannot but be regarded as a grievance in a country where so much depends upon a good maritime approach to its metropolis.

The practice of colliers anchoring in the stream, at the entrance to and in the pool, while preparing to take their respective stations, and hauling out into the fairway before the proper time to sail, is a just cause of complaint and productive of serious obstructions to navigation, as well as being a fertile source of accidents and injury. On no account whatever, therefore, should this malpractice be permitted to endanger the public safety.

The harbour-masters should be armed with authority to remove forthwith the obstructing vessel or craft, charging the offender with the costs, who should also be liable to a penalty. Each vessel ought to be provided with a boat well manned, a good kedge, and warps, in readiness to run out the latter to the nearest vessel in the tier, and thus ob-

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viate the necessity of letting go the anchor and encroaching upon the already too limited space assigned for navigation. An alteration in the bye-laws of the Port of London to this effect would confer a lasting benefit on the public.

The in-shore navigation (or transit for small craft) on each side of the river is also improperly obstructed by coal barges, which crowd the inner passages on the one side, and the loaded coal and timber barges, mischievously and unnecessarily *detained,* on the other, converting a serviceable portion of the river into floating warehouses; aud is, in consequence, so great a source of *hindrance* as to call loudly for strong remedial regulations.

It cannot be denied, however, that the increasing state of the coal trade in the Port of London loudly calls for dock accommodation, as, during the first six months of this year, the arrivals have exceeded the last or preceding period, by nearly 600 ships and 167,000 tons of coals; and, as the consumption of the article from the progressively increasing population, and the erection of manufacturing establishments, steam navigation, &c., is daily augmenting, the day is not far distant when some direction of the Corporation will be found necessary to oblige colliers to discharge in wet docks, and thus clear the river of an obstruction which now of necessity is tolerated, but which is, nevertheless, highly prejudicial to the trade of London.

The recent excellent plan of placing colliers in sections, is a positive benefit to the community, and calculated to effect a permanent improvement in the navigation of the Thames.

The quantity of rubbish daily and hourly thrown into the Thames, calls for serious consideration, and for the most energetic measures on the part of the Corporation to put an immediate stop to such irregularities, the tendency of which is to ruin the river. An Act of Parliament (54 Geo. III. c. 159,) has amply provided for these grave offences. And if due notice was given to every steam-boat that the laws on this head would be rigorously put in force, the fear

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of punishment (or information) might in some measure deter them from the open practice of such delinquencies.

The same Act of Parliament refers to the landing of rubbish upon the banks of the river, which ought to be placed above high-water mark (spring tides), and *out of the influence of storms or land floods, &c.*, on pain of fine or imprisonment.

This being the case, nothing more is necessary than the strictest supervision in order to detect the offender; as there are proofs on record that this shameless practice has been carried on from time to time, until it has become seriously detrimental to the river.

Next to those who wilfully and wickedly throw rubbish into the river, stand those who negligently allow their wharfs, banks, or forelands, to fall into it; and although the offence itself may not be of so serious a nature, the effect is the same; and as it is the duty of the authorities to punish delinquency on the one hand, so it will be in the execution of their office, as conservators of the Thames, to protect it from the effects of negligence on the other; and as it can be easily proved that the results are the same, it becomes the imperative duty of the proprietors of such lands to enclose safely that portion which is liable to be washed by the high tides, or exposed to the wave caused by steam-boats.

FRED. BULLOCK, Captain, R.N.

With this valuable and conclusive evidence, I now respectfully submit to the consideration of the Public the latest and enlarged description of my Plan for the Improvement of the Thames and Metropolis.

JOHN MARTIN,
30, Allsop Terrace, New Road,
London.

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W. C. Mylne, Engineer to the New River Company
E.G. Atherley, Barrister
Captain Doran
Rev. Dr. Spry, F. S. A.
Dr. John Forbes Royle, Esq. F. R. S.
Sir Robert Sydney
The Hon. Col. Leicester Stanhope
The Right Hon. Sir Alex. Johnston, Bart. F. R. S.
Allan Cunningham
J. I. Burn, Esq.
John M. Morgan, Esq.
W. R. Hamilton, Esq. F. R. S., V. P. R., A. S.
E. Protheroe, Esq.
E. H. Maltby, Barrister
W. Campbell, Esq.
H. Lloyd, Professor at Trinity College, Dublin
Rev. W. J. Hutching, M. A.
Dr. Corrie, M. D. Birmingham, President of the Philosophical Society
Charles Thompson, Barrister
W. Ewart, Esq. M. P. for Liverpool
Joseph Houlton, Esq. F. L. S.
Rev. R. Walpole, B. D., Rector of Christ Church Mary-le-bone
David Mocatta, Esq. Architect
Sir James Cockburn, Bart.
The Lord Mayor, Copeland, as an individual
Alderman Farebrother
J. Smith, Esq. Deanston, Civil Engineer
The Right Hon. T. P. Courtney

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E. T. Foley, Esq. M. P.
Francis Giles, Esq. Engineer
Joseph Comte de Survilliers–Joseph Bonaparte
L. Mailliard
Joseph Douglas, Temple
Ralph Thomas, Barrister
Alderman F. G. Moon

THE INSTITUTE OF BRITISH ARCHITECTS' LETTER.

TO JOHN MARTIN, ESQ.

43, King Street, Covent Garden,
3rd March, 1836.

My dear Sir,

As you were yourself present at the last ordinary Meeting of the Institute, held on Monday the 29th of February, you are fully aware of the intense interest with which the Members received the description of your admirable project for improving the discharge of the Sewage of this Metropolis, and relieving the Thames from those impurities which now so materially injure its waters, and affect the health of the inhabitants.

I am, however, directed by a Special Resolution, passed on that occasion, to present to you the thanks of the Institute for having submitted this important subject to their notice. Perhaps this acknowledgment may not be considered by you the less valuable, as proceeding from a body of Professional

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Men, whose practical experience enables them, even from so brief a view of the subject, to appreciate, in a general way, the important results which might arise from the adoption of a plan of such a nature.

I am, my dear Sir, with every expression of sincere regard, yours very faithfully and truly,

THOS. L. DONALDSON,
Hon. Secretary, and Corresponding Member of the Institute of France.

P. S. I am directed at the same time to enclose a Card of Admission to the Meetings of the Session, and to express the satisfaction the Members will experience in being favoured with your presence whenever agreeable to you.

The preceding list contains the names of those gentlemen who esteemed the objects of my Plan, as published in 1836, so desirable as to be willing to concur in its consideration. Since that period, I have prepared and published several stages of the Plan entirely at my own expense, and have succeeded in attracting and fixing public attention. Experiments have been made which most fully establish some of my proposals—works carried out, for example the sewer behind the Houses of Parliament—Government Commissions have been formed for Inquiry into Metropolis Improvements, Embankment, and Health of Towns—and Companies have been projected—all the objects being in perfect accordance with my *previous* suggestions. I cannot, therefore, but hope that those who co-operated with me in

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my early efforts, will still aid me and those supporters more recently obtained, in urging and promoting the measures, now that at least some of them are nearly obtained; for however favourable may be the present aspect of affairs, final success can only be secured by continued assistance and support.

Right Hon. Lord Robert Grosvenor, M. P.
Edward S. Cayley, Esq. M. P.
Wynn Ellis, Esq. M. P.
Edward Basil Farnham, Esq. M. P.
Charles Wood, Esq. M. P.
Robert Aglionby Slaney, Esq.
W. H. Hyett, Esq. F. R. S., of Painswick
Dr. Bowring, M. P.
Rev. John Connop, Bradfield Hall, Berks.
Rev. J. C. Blair Warren, Horkesley Hall, near Colchester

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THAMES AND METROPOLIS

IMPROVEMENT PLAN.

The distress which for a long period prevailed in our country, and which in some parts still continues to exist to a painful extent, is now admitted to arise mainly from want of adequate employment amongst the labouring and productive classes, causing that which should be the wealth of a nation—a crowded and rapidly augmenting population—to be regarded as a real evil, for which there is no apparent remedy but emigration. If the labourer is willing to work for moderate wages in his native land, the legislature ought surely to supply him with remunerative occupation; it is, therefore, with peculiar interest that all must regard the important discussions and measures now in parliament for ameliorating the condition of our humbler fellow countrymen. It is in accordance with this spirit, and my own conviction that we have at home ample means of productive employment for a

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population infinitely greater in amount, that I submit the following general observations to the public, with the hope that I may succeed in fixing attention to the necessity of advancing, by every possible means, such works as would effectually and permanently improve the condition of the poor, and benefit the interests of all classes throughout the United Kingdom. To promote these momentous objects, I would suggest that the land, which is acknowledged on all hands to be most imperfectly cultivated, should be *thoroughly worked in every way*, for the land will always produce in proportion to the labour that is put upon it. To effect this, all parts of the country should be completely drained by a permanent filter drainage, and then effectually and frequently manured; rivers should be embanked from their very sources, with good flood-gates, sluices, weirs, and locks, for the improvement of the navigation; the banks of the tributary rivulets should be lined where they are soft and earthy, to prevent the water from becoming muddy, choking the bed of the rivers, and thus injuring the navigation. By such means all bogs and marshes in the kingdom, and the immense flats along the banks of the Thames, Lee, &c., would be rendered most valuable land, and the air consequently so much improved that mansions might be built, and fertile gardens, orchards and

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parks formed, on spots now only dreaded as the sources of pestilence, fevers, and agues.

One of the greatest impediments to the improvement of the land is the cost of manure and manuring operations, for it appears that in well regulated arable farms the money value of the manure is on an average equal to the rental, and as the rental of the united kingdom is stated by Macculloch to be £52,069,852 per annum, whilst our foreign export trade is £41,649,191, the importance of saving every portion of manure, especially the town sewage, which is more valuable than any other, and exceeds in quantity all that is at present used, is sufficiently evident. By the system I propose in the following plan the cost of manuring would be reduced one half, the operation efficiently performed, double crops produced,* and full employment given to the poor—the whole forming a combination of objects so truly national as to deserve, and even demand the support and co-operation of the Government.

Without offering further preface, I will proceed to describe some plans which in some degree carry out my views; always impressing the prac-

* Mr. Dickinson had *ten crops* in succession upon the same land in 1844, by applying the liquid in covered watering carts.

About Edinburgh the crops are cut from four to six times a year.

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ticability of effecting any one of my objects either in part or wholly; but urging that the portion so taken should be in accordance with the general plan, so that at any time it might be carried further.

FIRST DIVISION.

IMPROVEMENT OF THE DRAINAGE OF THE METROPOLIS, AND PRESERPATION OF THE SEWAGE FOR AGRICULTURAL PURPOSES.

During the time which has elapsed since I published my plans for "Supplying London with Pure Water," and "Improving the Sewerage and Water of the Metropolis," in 1827, 1828, and 1832,* the attention of the public has been gradually excited by the publication of various able Reports on the "Sanitary condition of the labouring population throughout the country," and of the inefficiency and, in many districts, total absence of supplies of water, and of that drainage and ventilation so necessary to the comfort and health of all classes. The importance of the sub-

* Laid before Committees of the House of Commons on Metropolis Water Supply in 1827, 1828, and 1834; on Metropolis Sewers in 1834; on Metropolis Improvements in 1828; and before Her Majesty's Commissioners for Metropolis Improvements and Health of Towns in 1843.

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ject, and of speedily applying some remedial measures, being now so fully appreciated, several eminent practical men have associated themselves with me for the purpose of effecting one portion of my general plan for the improvement of the metropolis, confident that the accomplishment of my proposals will not only work to the desired end, but effectually and permanantly benefit both the agricultural and commercial interests of the country at large.

My plan, in its entire state, embraces the various objects of a perfect filter-tube drainage of land,—the supply of pure water to the metropolis,—the embankment of the river Thames from the source to the Nore,—the preservation of the sewage for agricultural purposes,—the improvement of the navigation below London bridge,—and the connexion of the port of London with the inland railways:—as, however, I wish to promote the interest, and explain the views, of the Metropolitan Sewage Manure Company, to the utmost of my power, I will distinctly separate that portion which relates specially to the preservation, removal, and distribution of the sewage for agricultural purposes.

The objects of this division are—to improve the drainage of the Metropolis; to prevent the sewage being thrown into the river, and thus to

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preserve in a pure state the water which the inhabitants are necessitated to use; to prevent the pollution of the atmosphere by the exhalations from the sewers, and the foul deposit in the docks and recesses on the banks of the river; to save and apply to agricultural purposes the valuable liquid manure from the sewers, which is at present entirely wasted; and to convey this liquid manure in close pipes to the land, without requiring receptacles either in town or country.

As it is obviously most desirable that the sewage of the town should be distributed so as to afford equal benefit to the whole of the surrounding country, and at the same time diminish the expense of conveyance, I propose that the Metropolis should be divided into separate districts; the sewage of each district to be prevented from entering the river, and forced by steam power through a main pipe, laid in the high road nearest to the source of supply; whence service and hose pipes would distribute it through and over the land where required.

To carry this out, it would be advisable to commence with the Western or Westmister District, which should again be subdivided into three sections; the 1st comprising the King's Scholars' Pond Sewer, the 2nd the Ranelagh Sewer; and the 3rd the Sewers from Westminster Bridge to

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Essex Street—the whole together, or either one separately being taken according to the means at command.

To effect the diversion of the sewage, I recommend that the sewer now formed behind the Houses of Parliament, should be taken up at Wood Street,* and continued down to King's Scholars' Pond Sewer, near the outlet of which the engine power will pump it up and force it through the main pipe laid along the shore, carried past Battersea Bridge, and thence diverging to the King's Road, to Fulham Road, through Walham Green, and up North-end Lane, into the Hammersmith Road near the church. The advantage of this line is that it passes through market-gardens, and the service pipes being laid on each side, the operations could commence at once upon 3000 acres of land; thus illustrating the object of the Company and affording a profitable return, during the laying of the main further onwards; besides being preferable to those lines that require the breaking up of streets and public thoroughfares, in which there are sewers, and gas and water pipes, and which proceed for nearly two miles before any operations can be attempted.

To effect the second division, a small inter-

* This sewer has been formed in accordance with my suggestion in 1836, and will be a saving in the proposed works of a quarter of a mile of sewer.

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cepting sewer should be formed between Chelsea Church and the outlet of the Ranelagh Sewer, where there should be a second engine, and the junction with the main from the King's Scholars' Pond district completed.

It is not proposed to alter the depth of the existing outlets of King's Scholars' Pond and the Ranelagh Sewers, but to attach self-acting flushing gates, and to lower the bed of the sewers adjoining the outlets so as to form the pump well for the engine, and afford power to keep the sewage, which is now liable to rise fifteen feet when backed by the tide, as low as the present base of the sewer; effecting a most essential improvement to the drainage and health of the surrounding district, as the Commissioners of Sewers have hitherto found it to be impracticable to maintain the sewage at a sufficiently low level at the main outlets of these sewers. The connecting the Parliament House sewer with the intercepting sewer will complete this benefit to the drainage of the whole low part of Westminster. As there is ample room in the great outlets of both King's Scholars' Pond and Ranelagh sewers for erecting all the necessary buildings, engines, &c., provided the authorities would approve of their being so appropriated, the purchase of land or interference with property would be avoided; and by laying the connecting

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main outside and close to the old embankment, it would serve as a protecting iron band, without obstructing the entrance to the docks, locks, creeks, &c., or encroaching upon either the old or new embankment, whilst it would be more rapidly executed, as excavations would not be required, and the barges could at once bring materials for the works.

The forcing engine, with hydraulic tower, for raising and pumping the sewage away into the country, should be as close to the great outlet as convenient, because all the sewage could then at once be intercepted without the nuisance of a reservoir, and the perfect ventilation of the sewers of the district would be effected by means of the fire of the engine; and their being so placed would also afford ready means for obtaining water for irrigation in dry weather. The hydraulic tower should be a handsome and ornamental structure, attached to the engine house, and containing the stand pipe, ventilating chimney, and staircase, and the top surmounted by a gas or Bude light, which would be seen both up and down the river, illuminating the country for miles around. At each engine station there should be a dredging wheel, to raise the silt and other refuse into barges, and prevent its entering the pump well, as shown in the plan; together with a self-acting flushing gate, to facilitate the passage

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of extraordinary floods, or surplus sewage: the intercepting sewers should have sluices for the same purpose, and the floods would then sweep the drains clean as they do at present, but without the disadvantage of being backed by the tide. This arrangement for the escape of the sewage will render the country receptacles unnecessary, until the agricultural demand shall be such that every particle of sewage will be diverted from the river, and the object of preserving the water from pollution completely attained; but even then it is questionable whether they may be required at all, as the manure would be in constant use in one locality or other.

As a further important improvement, which should be effected at the public expense, I recommend diverting that portion of the line of King's Scholars' Pond Sewer which passes under the right wing of Buckingham Palace, (see plan); and to obtain a perfect ventilation, as well as drainage, by proper slate valve traps, and covering in all those parts of the sewers which are now open, close to the Royal Palaces, Stafford, Clarence, Marlborough, and other neighbouring noble houses. The trap I propose to introduce prevents the escape of foul air, and the admission of silt, and consequent choking of the sewers: it also keeps back rats, and prevents all flooding of the houses in the lower levels, from any unusually high tide; and it

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acts with equal efficiency both in wet and dry weather.

The next district to be proceeded with should be the Hungerford Market section; the principal outlet being near the Northumberland Street Sewer, the average discharge from which is 692,382 cubic feet a day.* This division belongs to the Edgeware and St. Alban's Roads, with branches right and left. The district of the Fleet Sewer belongs to the direct North Road, or North Eastern Road; and so on round the Metropolis, each sewage district belonging to a proportionate country division, (*see plan*); for it is clearly unjust to convey to the east that which naturally belongs to the west; and it is also double labour and expense to discharge the whole at one point, and then to have to bring it back again for use upon the soil.

For the south side of the river, all the minor drains should be turned into the Great Duffield, or any other main sewer, and should be conveyed into the country and distributed as before explained.

This manner of preserving the manure from waste, and the water from pollution, should be adopted in every town and village throughout the kingdom; no refuse being allowed to escape, but every house, however humble, having a water-

* See Appendix, p. 44.

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closet communicating with the sewers, and the drains provided with valve traps, for the expense would be nothing in comparison with the advantages of the improved salubrity of the air, and the value of the recovered manure. The best method of distributing and applying the manure when preserved is all that now remains to be described.

It is already well known that "water can be conveyed in pipes 14 or 15 miles to elevations of 150 feet for 2½*d.* a ton, and afford a profit;" and the sewage manure, being as liquid as water, it is obviously equally capable of transport by the same means, and at the same rate, increased distance and elevation, within certain limits, being no obstacles.* Nevertheless, when the fluid *is conveyed* into the country, the mode of distributing it over the soil is the acknowledged difficulty—and this difficulty I have at length overcome. Hitherto only two systems of spreading fluid manure have been used—irrigation, and watering carts. and these under certain circumstances are inapplicable. Amongst the objections to the first are, the expense of preparing the land into numerous open channels and sloping plots, the very large quantity of fluid required, the waste, unless the ground is very regularly and evenly inclined, from the surplus quantity afforded to some parts,

* See Appendix, p. 41.

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whilst others are but inadequately covered;* the waste of the most valuable portion of the manure, the ammonia, by evaporation; and lastly, the important objection of irrigation being only applicable to *grass lands*, whereas the sewage manure appears to be more peculiarly valuable for arable lands; for Liebig states that, "it contains not only the most nitrogen, but also the most phosphates," and farther, "that with every pound of ammonia which evaporates, a loss of 60lbs of corn is sustained,† *(Chem. of Ag. and Organ. Chem.)* The distribution of the fluid by watering carts is free from the objections to irrigation; but on calculating the labour of men and horses, the numbers required, the distance to be travelled to and fro, and the consequent cutting up of the ground, together with the difficulty of using carts on tillage land,‡ and the various collateral expenses, the employment of watering carts is found to be impracticable upon a large scale. A consideration of these momentous facts, has led me to propose a system of distribution, by high pressure acting upon service and hose pipes, by which the fluid would be projected in any direction, in the same way as water is projected in extinguishing fires.* By these means, any quantity required, can be put upon the land, either to the

* See Appendix, p. 41.
† See Appendix, p. 28.
‡ See Appendix, p. 42.
§ See Appendix, p. 42.

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newly sown or growing crop, at any desired time: there can be no waste from evaporation, as the fertilizing matters, held in perfect solution in the water, will sink at once into the soil and be absorbed by the plant: and it has been found by an experiment recently made, that one man can with the hose distribute the fluid manure over an acre of land in the space of an hour; and this with a head or elevated tank of only 45 feet, the quantity discharged and the extent of distribution increasing in proportion to the height of the head or hydraulic tower. Thus the land would be quickly manured or watered without regard to ordinary obstacles, as the hose could be taken through copses, plantations, houses, over garden walls, across canals, or carried in straight lines to any given point; so that gardens or fields of small size could be manured without the man and hose even entering them, whereas the horse and cart would have to take a long circuitous course to enter each separate field. This system will also afford an extended means of protection from fire through the agricultural districts.

The following is, as briefly as possible, the entire system of operation:—to raise the sewage from the termination of the sewer by an engine and hydraulic tower, and to convey it by the mains along the most convenient public road leading to the country district, say from Chelsea to

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Colnbrook, Chertsey, and Bagshot; the service pipes to be laid both on the right and left sides of the main where the sewage may be required. The hydraulic tower should be surmounted by a cistern, to equalize the pressure upon the pipes and hose, and save labour in distribution; and the height of the tower such as to yield a sufficient pressure independantly of the drawbacks of rise of country, and loss by friction in the pipes. Great pressure will be absolutely necessary to prevent accumulation of either foul air or sediment in the pipes, and as the jet will be in proportion to the height of the column of fluid, more work would be effected in the same time with mains and pipes of much smaller size; the additional height of tower being therefore, in point of fact, economy in every way. It is, however a question of expense whether one high tower and powerful engine would cost more than two smaller towers and two lifts, or whether horizontal force might not in some cases be advisable instead of the hydraulic tower. The service pipes should be about half a mile, or in some instances a quarter of a mile apart; their junction with the main or large service pipes being at obtuse angles, on the principle of the fish bone; right angles being always as far as possible avoided, to diminish loss by friction, and obtain the utmost force of projection. A strong

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caoutchouc or woven hose, being in lengths of from 50 to 100 yards, which can be screwed together so as to extend into the field, should be attached to a tap in the pipe nearest the land to be manured; and no more than one tap should ever be open at the same time on any single length of service pipe, otherwise only that nearest the main would act effectively. Each set of hose appropriated to a station would serve for a considerable extent of service pipe, and be readily transported from one spot to another.

It may be desirable here to add a few suggestions as to the periods for applying the sewage, and the degree of strength of the various manurings. In the dry period of the year, when the sewage is strong and not abundant in quantity, the engine might be employed in conveying an additional quantity of water to the parched land; as important a part of the system as the manure itself, and giving a double claim for public support. The genial action of the summer sun should be checked as little as possible by applying the manure or water during the day, for by distributing the fluids at night they will reach the roots of the plant, and give nourishment without wasting by evaporation, and the full influence of the sun will operate upon the soil, and advance the ripening of the crop not less than a month or six weeks. Grass lands, which will

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yield several crops in the year, should be manured after each cutting; keeping in view that, when practicable, the process should go on at night.

Although it is evident that previous to any application of manure, the land should be prepared by a complete system of filter drainage, I have omitted in the foregoing discription all reference to the subject, with which my eminent friend, Mr. Smith of Deanston, is so identified. I may, however, be permitted to allude to the necessity for improving the drainage and cultivation of the Royal Parks around and near London, especially Regent's, Richmond, and Windsor Great Park; for if they were properly drained, and manured by the above mode, (which is peculiarly applicable to parks and pleasure grounds,) not only would their health and beauty be improved, but they would be rendered productive and profitable; and, as public parks ought to be, examples of good management and taste. If the drainage round the Virginia Water were perfect, the waters would be bright and clear, and the banks always dry, instead of spongy, as they now are for at least half the year. On a future occasion, when secured by a patent, I shall bring forward the explanation of my filter tube drain, plough, and slate valve trap, before mentioned, as the whole united would afford what I esteem to be the essentials of a system of complete drain-

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age; namely, that in land drainage the water should issue from the drain pure and bright as running streams, and therefore fit for the cattle tanks; the town drainage, on the contrary, should commence pure, and gradually increase in strength and impurity to the outlet, where it should be intercepted and sent into the country.*

Having thus far detailed the plan, I will merely add a few remarks regarding the support to be expected from those who will be directly benefited by it; and some observations relative to the change of my plan from the original continuous intercepting sewer, and solid manure, to the system above described.

As relates to the first.—The improvement to the Houses of Parliament, to Westminster and the adjacent district, by diverting the sewage, and covering and trapping the drains, is surely sufficient plea for obtaining support and assistance from the Government on public grounds, even apart from the benefit to agriculture, in affording means

* As some of the gentlemen with whom I am connected in the Metropolitan Sewage Manure Company may entertain different opinions on certain of the details I have entered into, it is due to them to state that the foregoing is merely an expression of my own views, founded, as regards the line, on my knowledge of the country, and on my examination into the subject in other particulars; but I am fully conscious that circumstances may demand many modifications, without however affecting the general principles we are endeavouring to carry out.

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of increased produce from the land. Part of the expense, however, ought certainly to be defrayed by the proprietors and inhabitants upon the line, since many of the advantages I set forth refer solely to the salubrity of the town, without in the least affecting the great object of applying the sewage to agriculture. The Chelsea Water Company in particular is an interested party, as its supply is derived between the two great outlets of King's Scholars' Pond and the Ranelagh Sewers; and as the tide ebbs and flows the reservoirs must receive the contents of first one and then the other, against which pollution, filtration is no remedy, for it only separates *suspended* matters, and has no effect on what is held in chemical solution.

For the unwholesome state of the water, owing to the sewage, I beg to refer to the following extracts from the evidence before the Committee of the House of Commons, upon Metropolis Water supply, 1828, and to the whole of that evidence, which most strongly proves the necessity of effecting a remedy:—

" A slender portion of common sense, however, authorizes me to affirm, that a stream which receives the daily evacuations of a million of human beings, of many thousand animals, with all the filth and refuse of the various offensive manufactories, which of necessity must be carried on in one of the most populous cities of Europe, cannot require to be analysed but by a lunatic, to determine whether it ought to be pumped

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up as a beverage for the inhabitants of the metropolis of the British Empire ; the question which you will decide, is not whether a few grains of this immeasurable filth can by chemical process be extracted from a bottle of water taken here and there, and subjected to the process of a tea-kettle elaboratory, but whether, without any process at all, this stream, palpably known to contain all this mass of filth, should continue to be supplied."—*From Mr. Beare's statement.*

" I was yeoman of the market (Billingsgate) twenty five years ago, and at that time there were four hundred fishermen, each having a boat and a boy fishing above and below bridge, and now there are not two hundred men engaged in this fishing, and many of them are selling off their nets and boats."—*From Mr. Goldham's evidence.*

" It is the putrescent matter which is the most obnoxious principle of common water ; it is a matter of common experience that water, according to its different qualities, affects the stomach with a peculiar feeling which we call weight."—*From Mr. Lamb's evidence.*

" In the year 1535, an Act was passed in the reign of Henry the Eighth, in which it was enacted, ' That if any person or persons do, or procure anything to be done, in the annoying of the stream of the river Thames, by cast- of dung, or rubbish, or other thing in the said river, he shall forfeit for so offending 100*s.* :' but this was not considered enough ; ' if any person or persons in great rains sweep their soilage or filth of their houses into the channels, and the same afterwards is conveyed into the Thames, every person so offending will forfeit for every such offence 1*s.* 8*d.*"—*From Mr. J. Wright's Memoirs.*

" In the reign of Richard the Second, 1390, it was enacted, " That no person do throw, or cause to be thrown or laid, any filth or ordure, muck, rubbish, or laystage, in the same water of the Thames, of the one side or the other, between the Palace of Westminster and the Tower of London, on loss of 10*l.*"

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For the change in the plan.—When I first proposed to apply the sewage to agriculture,* and to divert it by a continuous intercepting sewer, I was so far unacquainted with the nature and quantity of the sewage itself, as to suppose that a fall of only two feet to the mile was sufficient for the flow: but upon farther investigation, and inquiry from several intelligent Commissioners of Sewers, I found that to prevent accumulation and obstruction there should be a fall of not less than *fifteen feet* to the mile.† This, and the enormous size necessary for the sewer, rendered the single continuous line impracticable; and I, therefore, decided on dividing the whole into sections; by which I could obtain any desired fall, and reduce the intercepting sewers to even insignificant dimensions, by keeping the engine near the great outlet of the district. Amongst the other errors into which I fell were those common to every one who has as yet entered upon the subject—that the suspended matters and deposit were large in quantity and of superior value, whilst the fluid was esteemed a drawback, difficult to be separated and disposed of. These

* The erroneous remarks in page sixty-three of the Sanitary Report refer to this first state of my plan; Mr. Chadwick having overlooked the subsequent stages which I had laid before the public.

† See evidence of Mr. Donaldson, Roe, Kelsey, &c.

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errors have now been fully proved, as all the *valuable* solid matter is found to be completely dissolved; such extraneous substances as accidentally enter and form the deposit, being of little or no value as manure;* and these substances would be entirely prevented entering by following my recommendation of covering and trapping the drains, so that nothing but sewage water should flow down the sewers. What greatly enhances the value of this sewage water is, the fact of its being already in the readiest and cheapest† form for transmission by the unseen and unexposed method of engines, pipes, and hose: so vastly superior in all points to the costly and objectionable modes of conveying solid manure. Indeed, solid manure should only be employed where there is a deficiency of soil, or the soil is too light; though in such lands marling, or mixture of soils, would be the most efficient treatment previous to the application of the fluid manure. So greatly is fluid manure now estimated,‡ that Mr. Smith, of Deanston, whose testimony and authority are indisputable, recommends converting every description of manure that is soluble into fluid before putting it on the soil; and although all organic substances when in a state of decomposition are in reality effective manures, the sewage water ma-

* See Appendix, p. 38. † See Appendix, p. 40—44.
‡ See Appendix, p. 31—40.

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nure is more valuable than any other, as it is not only fully decomposed and ready for use without the least preparation, but it possesses far more nitrogen, which chemical science has proved to be a most effective source of fertility. The Quarterly Review, (No. 138,) aptly observes, that "when we reflect on the vast importance of nitrogen as an ingredient of grain, and on the fact that cow and horse dung contain very little of this element, we must see how essential it is not to waste any portion of liquid manure, the proper source of that portion of nitrogen which must be added to what is derived from the atmosphere before we can obtain rich crops of grain. But a still more important source of nitrogen is in the contents of our common sewers, which from a barbarous ignorance, are commonly thrown into the sea."

It is but necessary for me further to refer to some most important authorities on this subject, to make it evident, than even poudrette is of no value, and will not act without rain, or artificial irrigation. All the experiments of Sir Humphrey Davy, Sinclair, and others, tend to prove that fertilizers must be applied to the roots of plants in a fluid state, as the nourishment is immediately absorbed by the extremities;* even water alone is found to be an admirable manure,

* See Appendix, p. 29.

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acting as Lord Bacon says, "not only by supplying useful moisture to the grass, but likewise carrying nourishment dissolved in the water;" it is, therefore, more powerful in proportion to its impurity, flood water being the most valuable of any, as we learn from Lord Western, whose information on this point is most important and interesting. The importance of rendering the manure very liquid is admirably pointed out by Mr. Robertson, Mr. Knight, and the Gardener's Magazine, in its extracts from the Bulletin de la Sociéte de Genéve. The Flemings use the manure in a fluid state, as being more active, applying it the first year to the growth of hemp and flax, and the second for the cultivation of the best class of grain. Sir George Staunton likewise tells us, that "the Chinese construct large cisterns free from absorption, to contain besides the manure and soil of every kind, all sorts of vegetable matter, as leaves or roots, or stems of plants; with all these they mix as much animal water as can be collected, or common water, to dilute the whole; and in this state, generally in the act of putrid fermentation, apply it to the ploughed or broken earth. And Professor Liebig, in his profound and admirable "Organic Chemistry, in its application to Agriculture and Physiology," after forcibly showing the sources of fertility in soils, and dwelling on the employment of fluid animal

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manure, says, "How infinitely inferior is the agriculture of Europe to that of China! The latter is the most perfect in the world; and there, where the climate in the most fertile districts differs little from the European, very little value is attached to the (solid) excrements of animals." That the use of fluid manure was well understood by the ancients cannot be doubted; and in later times Evelyn gives some most interesting particulars regarding its aid and value. One hundred and ten acres belonging to Mr. Miller gave a clear profit of £2010 in 1827; and the annual expense of keeping them in repair is from 10s. to 15s. an acre. In 1826 part of the Earl of Moray's meadow brought £57 an acre; the land, however, usually lets at from £20 to £30 an acre. In detailing these facts, the northern position of Edinburgh, which is the same latitude as St. Petersburgh, must be considered; for furthur south, where the temperature is warmer, the produce would be superior

For further evidence as to the value of the sewage, and unwholsome state of the water, I refer to the appended extracts from Reports of Committees of the House of Commons, of Royal Commissions, and from various other sources. *(Appendix.)*

I cannot conclude this paper without expressing my cordial thanks to Mr. Smith, of Deanston,

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for his frank co-operation in different stages of my plan. When I first laid it before the Institute of Civil Engineers, Mr. Smith was so struck with it, that he made a rough calculation, and was subsequently induced to proceed further into the subject; since which period he has pursued it with an ardour and perseverance equal to my own. The difficulty of transmitting the sewage into the country having always presented itself, Mr. Smith suggested to me the superior advantage of employing pumping engines and pipes as the means of conveyance where it was to be distributed by irrigation. I had no hesitation in adopting the suggestion; but the objections to irrigation were so great and well understood, that I felt the necessity of introducing some other method; and after long examination and consideration, proposed the foregoing plan of distribution by service and hose pipes, with great altitudinal pressure—the modes of conveyance by pipes, and of distribution by hose combined, forming one uniform system. I likewise owe many acknowledgments, for information on agricultural and other points, to Mr. John James Moore, of Baljean, whose scientific attainments, actual practice upon his own large estate during many years, and perfect acquaintance with my plan, and the value of sewer water manure, have rendered him a most able coadjutor, whose ser-

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vices I have therefore procured to superintend the operations of the Company.

In the engineering and architectural department, I have sought and obtained the assistance of Messrs. MYLNE, TIERNEY CLARKE, HAWKSLEY, and FOWLER, whose eminent talents and experience render their support a sufficient as-assurance of the correctness and practicability of my proposals.

JOHN MARTIN.

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APPENDIX.

"THE primary nutriment of all animals consists of vegetable matter. All vegetable food contains a peculiar substance, called gluten or albumen; this substance is invariably present in nutritious food. Chemists were surprised to discover that this body never varies in composition; that it is exactly the same in corn, beans, or from whatever plant it is extracted. But their surprise was much increased when they remarked, that it is quite identical with the flesh and blood of animals. Thus plants contain within them the flesh of animals already formed, and the only duty of animals subsisting upon them is to give this flesh a place, a form in their organism. It is to Liebeg that we owe the discovery of this important fact.—*Dr. Lyon Playfairs' Lecture on the Applications of Physiology to the Rearing and Feeding of Cattle. No.* 1. *Delivered to the Royal Agricultural Society.*

The researches of Liebig "seem to have rendered it probable, that nitrogen cannot be secreted by plants direct from the atmosphere. It will then follow, that nitrogen, in order to furnish food for plants, must always have been previously combined with some other element, by which that tendency to assume an elastic state, which would prevent its assimilation, may be controlled. Hence the dependance of a productive wheat crop upon an abundant supply of animal manure, which, by disengaging ammonia, affords it this necessary element in a fit condition to undergo absorption; and hence the superior efficacy of liquid manure over every other kind, as it disengages a larger amount of volatile alkali.

"Fortunately, we are provided, in the dung of animals, with a species of manure of which the land never can be said

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to tire; and for this simple reason, that it contains within itself not one alone, but all the ingredients which plants require for their nutrition.

"The most effectual, as well as the most economical method of restoring the balance between the town and the country, would be to avail ourselves of that enormous accumulation of animal exuviæ which the existence of a crowded city necessarily occasions, and to convert that which is now a pabulum of disease into a source of life and abundance.

"I conceive our descendants will marvel at the inattention to chemical science evinced by the present generation of farmers, in importing from distant regions, such as South America, substitutes, and those perhaps imperfect ones, for that fertilizing material, of which the greater part is allowed to deposit itself unprofitably in the beds of our rivers."—*On the Application of Science to Agriculture, by C. Daubeny, M.D., F.R.S. Journal of the Royal Agricultural Society.* 1842.

"Every town and farm might thus supply itself with manure, which, besides containing the most nitrogen, contains also the most phosphates; and if rotation of the crops were adopted, they would be most abundant."—*Liebig's Chemistry of Agriculture.*

"It is the greatest possible mistake to suppose that the temporary diminution of fertility in a soil is owing to the loss of humus, (woody fibre in a state of decay,) it is the mere consequence of the exhaustion of the alkalis."—*Liebig's Organic Chemistry*, p. 149.

"It is remarkable, that among the many analyses of soils reported by Dr. Liebig, all the fine close sands are fertile, and the coarse loose sands, with one exception only, are barren."—*Essay on the Progress of Agricultural Knowledge during the last Four Years.*, by *Philip Pusey, M. P. in the Journal of the Royal Agricultural Society*, Vol. III.

"Organic matter containing nitrogen decays far more rapidly than that not containing this element. Animal manures, to a slight degree, modify the mechanical texture

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of the soil; though, from their great proneness to decay, the effects of this kind which they produce are comparatively transitory. Their principal value consists in the ammonia, and carbonic acid, or nitric acid, which they yield, and the earthy and saline compounds which they contain. In addition to this, they are also of value by facilitating the decomposition of vegetable substances employed as manure.

As, perhaps, the most useful part of these kinds of manure is the volatile substances formed during their decay, great care should be taken to suffer as little as possible to escape and be lost. It is probable that the best method of preserving the greater part of these matters is to dissolve it in water. The employment of liquid manure is gradually coming more and more into use, and the prejudices against its application are vanishing, as the beneficial results produced by its use become known."—*E. Solly's Rural Chemistry*, p. 126-8-9.

"The process of applying manure by irrigation, that is, separated and diluted with water, is considered to be productive of less deleterious gas, of less injurious effects, than by spreading it over fields in a solid form, and allowing it to remain until it is decomposed and separated by the atmosphere, and conveyed into the soil by rain. Liebig, the greatest living authority on agricultural chemistry, states that night soil loses in drying half its volatile products, that is, half its nitrogen, for the ammonia escapes into the atmosphere. By irrigation, by the diffusion and conveyance of the manure to the plant in the medium of water, the escape of the valuable substance as a noxious and injurious gas is diminished. Whatever extent of loss there is from manures by decomposition, when placed on the land in a solid form, and when exposed to the action of the atmosphere, it is stated that there is proportionate gain by holding the material in suspension in water."—*Sanitary Report.* 1842

"Sir Humphrey Davy proves that no solid substances can enter in that state into the plant. Vegetable and animal substances are consumed during the process of vegetation; and they can only nourish the plant by affording solid matters

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capable of being dissolved by water: the great object, therefore, in the application of manure should be, to make it afford as much soluble matter as possible to the roots of the plant, and that in a slow and gradual manner, so that it may be entirely consumed in forming its sap and organised parts.

"Night soil, it is well known, is a very powerful manure, and very liable to decompose. From the analysis of Berzelius, it appears that a part of it is always soluble in water; and in whatever state it is used, whether recent or fermented, it supplies abundance of food to plants."—*Loudon's Encyclopedia of Agriculture*, p. 333-4-9.

"It was discovered by Davy that human manure and the best soils equally evolve the four gases so necessary to vegetation.

"Manure in Flanders, as in China, is an article of trade. The frequent manurings given by the Flemish farmer astonish a stranger; the sources whence it is obtained in sufficient quantity form the difficulty; and this can only be resolved by referring to the practice of soiling, to the numerous towns and villages, and to the care with which every particle of vegetable and animal refuse is saved for this purpose. Cisterns are formed in the fields, to receive purchased liquid manure; but for that made in the farm-yard, generally in the yard, or under the stables. This species of manure is relied on beyond any other, upon all the light soils throughout Flanders; and even upon strong lands, (originally so rich as to preclude the necessity of manure,) it is now coming into great esteem, being considered applicable to most crops, and to all the varieties of soil.

"The Tuscan farmers are assiduous in preserving every particle of human and animal manure as the Flemings."—Ibid. p. 51, 80, 82.

"It is to the use of this substance, (town refuse,) drawn from reservoirs in the towns, that Belgium, in a great degree, owes her fertility; while, in many large cities in Germany, it is allowed to drain into the rivers. Since 1200 pounds weight of it yearly may be reckoned for each unit of popula-

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tion, it is easy to see, where population is counted by millions, how important its application must be."—*Professor Sprengel, on Animal Manures. Journal of the Royal Agricultural Society.* 1840.

"The effect of liquid manure on poor loose sand, if not seen, would not be credited. If a portion of the unimproved original soil were produced, and compared with that which has been many years in cultivation, it would be difficult to persuade a stranger, not acquainted with the system of gradual improvement, that the latter was as poor as the former." —*Agriculture of the Netherlands, by the Rev. W. L. Rham. Journal of the Royal Agricultural Society.* 1842.

"One hundred parts of wheat, grown on a soil manured with cow-dung, (a manure containing the smallest quantity of nitrogen,) afforded only 11·95 parts of gluten, and 62·34 parts of amylin or starch; whilst the same quantity, grown on a soil manured with human urine, yielded the maximum of gluten, namely 35·1 per cent, or nearly three times the quantity."—*Liebig's Chemistry of Agriculture.*

"A great, but not sufficiently estimated advantage, which arises from manuring with urine, consists, undoubtedly, in the quicker return effected on the capital of manure, in consequence of its being applied to plants already in a growing state. In the case of manuring with solid excrements, a period of two or three years may elapse before complete decomposition ensues, and the plants have derived the full advantage. The crops, too, during this period, lose much of the manure, in consequence of its best portions being drained away by the snow and rain water.

"Lastly, one of the uses of manuring with urine, which has hitherto been little regarded, consists in this,—that earth-worms, and the larvæ or grubs of various insects, which in many countries, for instance the Upper Weser, do such extraordinary injury to the young rye, are destroyed by it; this effect is produced, as my own experiments made expressly on this point have shown, by the ammonia of the urine; for, if we water a field much infested with earth-

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worms, with a solution of carbonate or caustic ammonia, the worms come immediately to the surface, writhe for some time, and then die. Probably, also, the cockchafer grub, when not too deep in the ground, might be destroyed in the same manner; a fact that would be of great importance to many districts."—*On Animal Manures, by Professor Sprengel. Journal of the Royal Agricultural Society.* 1840.

"It is, from long experience, an admitted fact among the German farmers, that there are no manures so powerful in their operation as those which are liquids, such as human urine or bullocks' blood; so that no English farmer need fear deception as to their asserted value. This very fact was submitted, some years since, to the consideration of Professor Hembstadt, of Berlin, by the Saxon and Prussian authorities, who were anxious to apply the contents of the city drains towards fertilizing the barren lands in the neighbourhood of Dresden and Berlin. This talented agriculturist undertook, in consequence, a series of valuable experiments, which, varied in every possible way, were carried on for a considerable period: the result of them, so highly advantageous to the prosperity of Germany, Hembstadt then published. They were repeated with unvaried success by Professor Schübler, and the results may be stated in the following order:—

If the soil, without any manure, yield a produce of three times the quantity of seed originally sown, then the same quantity of land will produce:

5 times the quantity of seed sown, when dressed with old herbage, grass, leaves, &c.
7 times when dressed with cow-dung.
9 times, with pigeon's dung.
10 times, with horse-dung.
12 times, with *human urine.*
12 times, with sheep's dung.
14 times, with *human manure*, or *bullocks' blood.*

—*Essay on Liquid Manure, by Cuthbert Johnson, Esq. Journal of the Royal Agricultural Society.* 1840.

"There is hardly a single ingredient found in urine which

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is not either a direct food for vegetation, or furnishes by its decomposition a supply in another form; for in it are thus detected the ammoniacal salts of the dunghill, the phosphate of lime of bones, as well as of many cultivated vegetables, and abundance of easily decomposable animal matters."—*Prize Essay on Liquid Manure, by C. W. Johnson, Esq. Journal of Royal Agricultural Society*, vol. i. p. 156.

Dr. Daubeny, in his lectures, also gives a curious table of similar effects of gluten, increased by *different* manures, and it is remarkable, that the order in which each of these manures, with one exception, gave the greatest quantity of gluten, is exactly that in which they contain the greatest quantities of ammonia or nitrogen. Now experience has taught us, that well fed animals produce manure, and in their own decay afford manure rich in the proportion in which they are richly nourished. Thus, man and all carnivorous animals feeding on a substance rich in nitrogen, afford a manure also rich in nitrogen."—*Lecture by W. H. Hyett, Esq., of Painswick to the Farmer's Club, at Gloucester, Dec. 4th*, 1841.

"What do we waste?—Town Sewage. It is generally considered that those crops, wheat, barley, &c., which yield food for *man*, are the most scourging crops we can grow. Now, what would be said of the farmer who would allow all the manure derived from the less scourging crops which he grows, such as turnips, grass, &c., food for *cattle*, to run wholly and utterly to waste. Whatever might be the blame which he would receive, double the amount must certainly attach to those who waste the similar produce of our grain crops, and of the other farm productions sold as food for man. The waste of town sewage, to which we allude, is unquestionably productive of very great national loss.

"Gas water contains about 3lbs of ammonia in every ten gallons.

"How is this waste to be avoided? Companies are being formed for the collection and sale of town sewage manures, and we shall soon direct attention to their operations. These should be heartily patronized by the intelligent farmer, for on their success depends the period when the wretched policy

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hitherto pursued on this subject shall cease."—*Subject for discussion at Farmers' Clubs, proposed in Gardeners' Chronicle, January 31st*, 1846.

"Some of the meadows irrigated by the sewage water of Milan yield a net rent of 21*l.* per *tornatura*, (a measure of 10,000 square metres, equal to about two acres and a half,) besides a land-tax of 61 franks 10 cents, the expenses of administration, repairs of buildings, &c. These meadows are mowed in November, January, March, and April, for stable-feeding; in June, July, and August, they yield three crops of hay for the winter; in September they furnish an abundant pasture for the cattle, till the beginning of the winter irrigation."—*From the First Report of the Health of Towns Commission.* Vol. ii. p. 403.

"At Ashburton (in Devonshire) they have carried on this practice more than forty years within my own recollection. They have grass for the ewes and lambs a full month earlier than in most other situations. The general value of such land when unimproved is usually worth from 30*s.* to 40*s.* per acre, when so improved is worth from 8*l.* to 12*l.* per acre.

"I have known some instances, where the land has been favourably circumstanced, where the water has been applied to drill crops, such as peas, beans, and the usual garden products; with which it was very successful, especially with strawberries, producing more abundant crops, and much earlier, than could have been obtained by any mode of top-dressing.

"In respect to the difference of productiveness of irrigation and top-dressing, instances have been adduced where lands, by the use of stable or town manure as a top-dressing have only had the ordinary produce increased one-fold under favourable circumstances; while portions of the same land lying convenient for irrigation have had the produce increased at the least five fold by the application of the same manure in the liquid form."—*From the Evidence of James Dean, Esq., before the Health of Towns' Commission. First Report*, vol. ii. p. 406.

The value of manure is sufficiently shown in the amount of

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capital which has been embarked in the trade for African and Peruvian guano. Yet it is an indisputable fact that every city, yea, every village, throws to waste all the active principles contained in this far-sought treasure. The sewers of the metropolis alone pour out into the Thames annually, more of the nitrogenous and other matters, which are proved to be valuable food for plants, than all the islands of Peru or Africa can afford us.

"In a kingdom like our own, where there exists a very dense population, with a natural disposition to a rapid increase, the improvement of the soil becomes a momentous question to the community—whilst to the farmer, who, liable as he is to the uncertainties of our climate, and to a keen mercantile competition, is desirous of securing, and indeed of increasing, his annual product, to insure a remunerative return for his property, his anxieties and his labour, the subject is one of vital interest."—*Athenæum, Notice of Agricultural Works*, Feb. 22, 1845.

"The value of town manure may be estimated by the fact, that a portion of the drainage of Edinburgh spread upon certain level lands towards the sea has increased the value of these lands by more than £5,000 a year; and that, if the whole drainage of London could be so used, at a sufficient distance from the town, the value would exceed £500,000 a year. Now engineers, who pump from the Thames many miles above London to supply pure water to the inhabitants, could as easily, by pumping away to any desired distance the fluid from the drains, supply the most valuable manure yet known (fluid town manure) to the horticulture and agriculture of the district; and the purity and beauty of the Thames, where it passes through London, would be preserved. Fluid manure, by sinking at once into the earth, is much less offensive to the neighbourhood, and effects less the purity of the atmosphere, than an equal quantity of solid manure spread, as it usually is, on the surface of the earth."—*Dr. Arnott's Report on the Fevers which have prevailed in Edinbugh and Glasgow*, p. 12.

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"The water *containing the soluble parts is of great use,* and is carefully applied to the irrigation of grass lands. Such ground is annually kept in grass, and yields from *three to six cuttings* in the season."—*Extract from a Letter of Mr. Thomas Oliver of Lochend, addressed to a Committee of Gentlemen appointed to Report upon Mr. Martin's Plan, printed* 1836.

"Edinburgh has many advantages over many of her sister cities; and the large supply of excellent spring water is one of the greatest blessings to her inhabitants, both in respect to household purposes and in keeping the streets clean, and lastly in irrigating the extensive meadows situated below the town, by the rich stuff which it carries along in a state of semi-solution, where the art of man, with the common-sewer water, has made sand-hillocks produce riches far superior to anything of the kind in the kingdom or in any country.

"By this water about 150 acres of grass land, laid into catch-beds, is irrigated, whereof upwards of 100 belong to W. H. Miller, Esq., of Craigintinny, and the remainder to the Earls of Haddington and Moray, the heirs of the late Sir James Montgomery, and some small patches to other proprietors. The meadows belonging to the last-mentioned noblemen, and part of the Craigintinny meadows, or what is called the Old Meadows, containing about 50 acres, have been irrigated for nearly a century. Although the formation is irregular, and the management very imperfect, the effect of the water is astonishing; they produce crops of grass not to be equalled, being cut from four to six times a-year, and given green to milch cows. The grass is let every year by auction, in small patches, from a quarter of an acre and upwards, which generally brings from £24 to £30 per acre. This year (1836) part of the Earl of Moray's meadow gave as high as £57 per acre."—*From Mr. George Stephen's Essay on Irrigated Meadows, published in* 1826, pp. 72, 73.

"In the spring of 1821, 30 acres of waste land called the Freegate Whins, and 10 acres of poor sandy soil, were levelled and formed into irrigated meadow, at an expense of

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£1000. The pasturage of the Freegate Whins was let, previously to this improvement, for £40 per annum, and the 10 acres for £60; they now bring from £15 to £20 an acre per annum, and may be much improved."

"The practical result of this application of sewer water is, that land which let formerly at from 40*s.* to £6 per Scotch acre, is now let annually at from £30 to £40; and that poor sandy land on the sea shore, which might be worth 2*s.* 6*d.* per acre, lets at an annual rent of from £15 to £20. That which is nearest the city brings the higher rent chiefly because it is near and more accessible to the points where the grass is consumed, but also from the better natural quality of the land. The average value of the land irrespective of the sewer water application may be taken at £3 per imperial acre, and the average rent of the irrigated land at £30, making a difference of £27; but £2 may be deducted as the cost of management, leaving £25 per acre of clear annual income due to the sewer water."—*Evidence of James Smith, Esq. Deanston. Report of the Health of Towns Commission*, Part ii. Appendix, p. 326.

"Analyses (of the Edinburgh sewer water) made by Mr. Phillips, the Government Chemist, at the Museum of Economic Geology, namely:

No. 1. Water taken up immediately on its leaving the sewer.
2. Taken as it flowed from the subsidence pond.
3. Taken after having flowed over one plat.
4. Taken after having flowed over several plats.
5. Taken still further on.
6. Taken at the sea.

The analyses stand thus:

	Solid Matter in Suspension	Solid Matter in Solution	Sulphuretted Hydrogen Gas
The gallon of No. 1 gave	244 grains	82·7 grains	20·4 cubic ins.
„ 2 „	52 „	87 „	10·4 „
„ 3 „	31 „	89 „	11·8 „
„ 4 „	15 „	82·7 „	9·2 „
„ 5 „	2 & a half	67·2 „	11·4 „
„ 6 „	2 & a half	72·9 „	1·1 „

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"From these analyses it will, in the first place, be observed that a large deposit of the matter held in suspension takes place in the pond, and that there is in the first plot of ground a similar deposit of considerable amount; but, as the water advances the deposit diminishes, until there is eventually little left in suspension. On looking to the column in which the matter held in solution is given, it will be found that the proportion of the fertilizing matter in solution rather increases after the first application, and is sustained with very little diminution to the end. The matter which is deposited in the ponds is found to be of comparatively little value, being composed chiefly of cinders and other undecomposable substances.

"I observed, on going over the meadows (in the neighbourhood of Edinburgh) so irrigated with the sewer water, that the offensive smells complained of by some of the neighbouring inhabitants, as arising from the meadows, emanated mainly from the masses of decomposing matter left in the ponds, and not so much, if at all, from the water holding only fertilizing matter in solution."—*Evidence of James Smith, Esq., of Deanston. Health of Towns Commission. 2d Report*, p. 173-4.

"In the case of Edinburgh the increase of the value of poor lands thus irrigated, is shown to have been from 30*s.* to £15, and in some cases to £20 per acre; other lands, once let for 40*s.* to 50*s.* per acre, now let for very high sums. It is true, that the inhabitants around those meadows object to it as offensive; the value, however, of the irrigation is seen by the parties interested in about 300 acres of land, estimating the compensation that would induce them to discontinue that practice at the sum of £150,000."—*Evidence of Mr. Roe, C. E. Health of Towns Commission.* First Report, p. 704.

The value of this mode of agriculture has also been proved on an extended scale, in the Duke of Portland's water meadows at Clipstone Park. The course there pursued has been chiefly one of irrigation, the water being but slightly imbued with sewage manure. It is, however, a striking illustration

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of the still greater advantages obtainable from fluid sewage manure.

"The land immediately occupied by these meadows was, in its wild state, a line of hill sides covered with gorse and heather—a rabbit warren, over which a few sheep wandered —and a swampy valley below, thick set with hassocks and rushes, the favourite haunt of wild ducks and snipes; through which the little stream, the Maun, wound its way in its descent from the town of Mansfield.

"The whole tract, both upland and lowland, was of very little value. The valley was in many parts from nine to ten feet deep in bog, and almost worthless; the hill sides varied in quality, but £80. a-year would have been a full rent for the 300 acres. Indeed the whole of the Clipstone Park Farm when taken in hand in the year 1816, containing 1,487 acres, had been let for the sum of £346.

"The effect of this irrigation has been to raise the annual value of this land from 4*s.* 6*d.* to 11*l.* 4*s.* per acre."—*Journal of the Royal Agricultural Society of England*, vol. i. 1840, p. 356, 367.

"When the situations have been favourable, as at Rye, for giving a rapid fall to the drain, I placed a loose covered tank or cesspool at some distance from the building: the tank was formed for the preservation of the refuse, and its application to agricultural purposes as liquid manure. In one instance of some land manured by the liquid manure applied by water-carts, the produce of the land was stated to have been doubled."—*Evidence of Mr. S. O. Follen. Health of Towns Commission.* First Report, p. 353.

"William Dickinson, Esq., of London, after strongly recommending the use of covered drains for the preservation of ammonia in liquid manures, stated that by the use of liquid manure he had last year produced ten crops of grass in succession upon the same land. The first was cut in March, with about ten inches of grass; it was cut a second time on the 13th of April; a third time on the 4th of May; a fourth time on the 24th of May; a fifth time on June the 14th; a

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sixth time on July the 22nd, with ripe seeds, and three loads of hay straw to the acre. Immediately after each of these crops, the land was watered once from a London street water-cart, with two parts of urine from the stables, and one part of water; the produce of each crop increasing with the temperature of the atmosphere, from three quarters of a load per acre as hay, to three loads per acre. It produced four light crops afterwards; and he had standing upon it in July last three loads to the acre, the third crop for seed. The first cutting during the present year was not until the 6th of April, the second on May the 3rd, the third on June the 9th, the fourth (2½ feet long) was standing in last month."—*Gardeners' Chronicle and Agricultural Gazette, Aug.* 23, 1845.

"By an experiment made last season, on a portion of meadow in Lancashire, applying at the rate of 10 tons of farmyard manure per acre, and 3 cwt of guano to another equal portion, their effects were found to be inferior to the 8 tons of sewer water applied to a similar extent of ground."

"The water applied (in the preceding experiment) not having been analysed, I cannot estimate the amount of fertilizing matter contained in it; but assuming a similar quantity to that found in the Edinburgh sewer water, the amount applied must have been about 1792 gallons per acre, which is much less than the quantity I proposed to apply to tillage land.

"I conceive that the aim of a good system of sewage is to get rid of every cess-pool and every partial deposit of filth, and to send the whole by the speediest course through the main sewer into the country; and that not a particle of such matter should be lost or wasted, except in times of floods from heavy rains, when the diluted matter would become too voluminous to be all retained for agricultural purposes. The finest formed sewers, and the best arrangement of them, would be of no use without an adequate supply of water. The drains but furnish the ways or vehicles for transportation; the water is the moving power or carrier, and it is the cheapest that can be procured."—*Evidence of Captain Vetch, C. E. Health of Towns Report,* (No. 1,) p. 441-2

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"The cost of transmitting water to a distance is very trifling indeed. Distance is scarcely any element in the expense of the conveyance through pipes; in fact, the pipe is a sort of continuous cart, which it is not necessary to move. You put the water into motion at one end, and whatever force you apply at that end is transmitted, minus the friction, to the other. You have not to carry the weight of the cart or of the horse with you.

"The cost of transmitting water to a distance of five miles, and to a height of 200 feet, including wear and tear of pumping machinery, fuel, labour, interest of capital invested in pipes, reservoirs, engines, &c., amounts to about 2½*d.* per ton. The cost of cartage to the same distance and height will, under favourable circumstances, amount to 4*s.* per ton." *Evidence of T. Hawksley, Esq. First Report of the Health of Towns' Commission*, 322.

"On a full examination of the evidence adduced, and of the evidence indicated, it will, I trust, be found to be satisfactorily established, that the natural streams flowing near towns may be preserved from the pollution caused by the influx of the contents of the public rivers, by the conveyance of all refuse through covered pipes.

"By the application of capital and machinery, the cost of conveyance of substances in suspension in a fluid, even at the water companies' prices, may be rendered thirty and even more than forty times as cheap as collection by hard labour and removal by cartage. In the metropolis, where the persons who water the roads may obtain water gratuitously from pumps, the water supplied by stand-pipes by some of the water companies at 1*l.* per 100 tons is found to be twice as cheap as the mere labour of pumping the water into the cart." —*Report of the Poor Law Commissioners*, &c. p. 63, 53. Also the Evidence of Mr. Dean in Health of Towns' Report.

"Taking a general view of the subject, we may assume a clear revenue from the sewer water of all towns of 1*l.* for each inhabitant, either in a direct money return, or partly to

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the inhabitants in a reduced price, from the increased abundance of produce.

"I have ascertained that the quantity of sewer water due to a town of 50,000 inhabitants amounts to about 1,190,080,946 gallons per annum, which quantity will yield an annual application of 17,920 gallons per acre to an extent of 66,410 acres. Taking the average cost of guano and farm-yard manure at 2*l.* per acre, and deducting 12*s.* 9*d.*, the cost of the application of the sewer water, there will appear a saving due to the sewer water of 1*l.* 7*s.* 3*d.* per acre; allowing one half thereof to go to the farmer, there will remain a free income due to the sewer water of 45,241*l.*, which is nearly 1*l.* per head of the population."—*Evidence of James Smith, Esq., Deanston.* *Report of the Health of Towns' Commission.* Part ii. Appendix, p. 328.

"The water could not well be distributed over the open tillage land by irrigation; it would therefore be necessary to resort to some mode of distributing it by jet. This requires the conveyance of the water in pipes, under a pressure of from 100 to 150 feet of altitude, to a number of convenient points in the farms where it is to be used. In this there is no difficulty: it is a simple engineering question, the success of which is certain, while the cost can be estimated on known data. I made an experiment on a large scale at the Southwark Water Works, which satisfied me of the practicability of distribution by jet. With an altitudinal pressure of 120 feet of water, and using a 2½ inch hose, with a discharging orifice or nozzle of one inch in diameter, I found that I could from one point distribute water over an area of two statute acres—but, to be safe, say one statute acre. Dividing the quantity so required annually into three portions, for separate applications, one jet of one inch orifice will deliver each portion in about an hour, as ascertained from data founded on an experiment made the same day, to ascertain the quantity of water discharged in a given time from a smaller orifice with a similar pressure.

"Estimate of the probable expense of receiving tanks,

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pumping engines, pipes, hose, &c., for raising, conveying, and distributing sewer water over an area of four square miles, (equal to 2560 acres) :

Receiving tanks or ponds	500	0	0
30 - horse pumping-engine, engine-house, chimney, &c.	2,000	0	0
*Three miles of 12-inch main-pipe	3,704	0	0
Sixteen miles of fire-clay service-pipes. . .	2,020	6	5
Hose with screw joints	283	4	0
Plug-cocks	128	0	0
	8,635	10	4
Contingencies, 10 per cent. . .	863	11	2
Outlay for 2,560 acres	9,499	1	6

For one acre, 3*l.* 14*s.* 2*d.*

" Estimate of the probable annual expense of the application of 17,920 gallons of sewer water per acre, which will contain 5 cwt. of dissolved and suspended matter, and which is considered to be equal to a dressing with 2½ cwt. of guano, or 15 tons of farm-yard manure :

Raising 45,875,200 gallons 200 feet high to be distributed over 2,560 acres, allowing 17,920 gallons per acre, at 2*d.* per 2,400 gallons .	159	15	1
Annual wear of hose	93	12	0
Management, and wages of men employed in distributing	348	0	0
Rates and Taxes	320	0	0
Interest on sunk capital 9,499*l.* 1*s.* 6*d.*, at 5 per cent	474	19	0
Allow for repairs and sinking-fund two and a half per cent. on outlay	237	9	6
Annual expense of application to 2,560 acres	1,633	15	7
Cost of manuring one acre with sewer water .	0	12	9
,, guano, two and a half cwt. at 8*s.* .	1	0	0
,, form-yard manure, 15 tons, at 4*s.*	3	0	0

* One half of the cost of the main-pipe is only charged, as from its position and capacity it is sufficient to supply other sections of land of equal extent.

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Sewer water is cheaper than guano	0	7	3
„ farm-yard manure	2	7	3
„ the average of the two	1	7	3

Evidence of J. Smith, of Deanston, Part ii. Appendix.

"The general conclusions deducible from these experiments (made in dry weather during the months of May, June, and July, 1844) are:

"That the mean discharge per acre, taking the whole surface drained, urban and suburban, is about 256 cubic feet in twenty-four hours.

"Assuming (as regards the relative proportion of urban and suburban) the district to which the accompanying observations refer to be a fair type of that included within the whole of the Metropolis Commissions of Sewers, and taking the extent of the active jurisdictions of those on the north side of the river Thames at forty-three square miles, and the jurisdiction of the Surrey Commission at fifteen square miles, the ordinary daily amount of sewage discharged into the river on the north side would be 7,045,120 cubic feet, and on the south side 2,457,600 cubic feet, making a total of 9,502,720 cubic feet, or a quantity equivalent to a surface of more than thirty-six acres in extent and six feet in depth." —*Extract from a Report of the Average Discharge of Sewage through principal outlets, printed by order of the Court of Sewers for Westminster and Middlesex, 3rd Oct.* 1845.

"Number of Sewers which discharge into the river on the north shore, from Vauxhall to London bridges, and the aggregate dimensions at their outlets:

	No.	Aggregate size Height ft. in.			Width ft. in.
From Vauxhall to Westminster Bridge .	5	37	0	by	18 3
Westminster to Waterloo Bridge .	20	85	10	-	61 1
Waterloo to Blackfriars	27	106	3	-	83 3
Blackfriars to Southwark . . .	42	114	6	-	88 9
Southwark to London	19	56	1	-	44 0
	113	392	8	by	295 4

"It appears from this table (in Alison's Principles of

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Population, p. 435-6) that there were in 1827, 46,500,000 arable acres cultivated in Great Britain and Ireland, and 15,000,000 uncultivated, but capable of improvement. The average produce of each cultivated acre may be taken in grain, or other substances equally or more nutritious than grain, at two quarters. The total amount of the subsistence that might be raised in 46,000,000 of acres would be 92,000,000 of quarters. A considerable proportion of the produce is doubtless consumed by the horses, which by the latest return amount to nearly 1,343,000, and has probably now reached 2,000,000, in the United Empire: and Arthur Young calculates that each horse consumes as much food as eight men, or about eight quarters, a quarter to each human being forming the average consumption for the whole year. At this rate the horses would consume subsistence to about the amount of 16,000,000 of quarters a year; and suppose that a half more, or 24,000,000 of quarters, is required for cows, butcher meat, &c., there would still remain land capable of producing 52,000,000 of quarters a year, at the very moderate rate of two quarters or sixteen bushels an acre. Now the average consumption of each human being is one quarter. This would maintain nearly double the present population of 28,000,000 in the United Empire, without taking into view the probable cultivation of 15,000,000 of acres of waste lands not yet reclaimed, or probable improvements in agriculture, which, especially by the introduction of draining, may be reasonably expected to add at least half to the assumed estimate of two quarters or four bolls to an acre. [The improved system of manuring would double it again.] Nothing, therefore, seems more reasonable than to hold, that the British Islands contain within themselves the means of maintaining in comfort, at least triple their present population; and, consequently, all arguments drawn from the supposed impossibility of adequately maintaining our population from our own agricultural produce, or of the inhabitants soon approaching the limits assigned to the increasing subsistence, are perfectly chimerical and absurd."

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"The average produce of all the counties in England stands thus:

	Qrs.	Bushs.
Wheat	2	5
Barley	4	$0\frac{1}{4}$
Oats	4	$3\frac{1}{2}$
Rye	2	$7\frac{3}{4}$
Pease	2	7
Beans	3	$1\frac{3}{4}$
Potatoes	280	

Macculloch's Statistical Account of the British Empire.

"According to official papers laid before Parliament, the importation of guano has increased from 1733 tons in 1841, to 220,934 tons in 1845; employing a fleet of 683 sail, and 11,486 men. This quantity of guano must have sufficed to manure between 2,000,000 and 3,000000 of acres."—*Gard. Chron. March 28th*, 1846.

THE END.

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THAMES AND METROPOLIS IMPROVEMENT PLAN.

THIRD DIVISION.

THE objects of this Division are—"to connect all the railways entering the town with each other and with the docks, and thereby enabling an unbroken communication to be maintained between all parts of the country through the Metropolis."—See REPORT OF THE COMMISSIONERS ON METROPOLITAN TERMINI.

BY JOHN MARTIN, K.L.

LONDON:

30, ALLSOP TERRACE, NEW ROAD.

1846.

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THE LONDON CONNECTING RAILWAY.

As it is acknowledged that the various railways leading to the Metropolis require to be connected with one another, and to communicate freely and easily with the port and different districts of London, on both banks of the river, I will endeavour to describe the line I have laid down, and a referenee to the map will show that while the Railway is connected with the very heart of the city itself,—will touch every railway both existing and projected,—and border closely upon all the populous quarters,—yet that these advantages will be effected without encroaching upon private property, injuring vested interests, or interrupting present lines of traffic and communication within the Metropolis.

The following enumeration of the principal places will suffice. The Railway should commence at the River, close to the East India Docks, cross over the River Lea, and Limehouse Cut at Bromley, Mile End Road, near Stratford-

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le-Bow, form a junction with the Eastern Counties and Northern and Eastern Railways, and join the Blackwall Railway by a Branch down to Limehouse and the River; it should prooceed past Victoria Park and Bethnal Green, Hackney, Shoreditch, and Hoxton, connecting in its course the Kingsland, Islington, Holloway and Liverpool Roads; past White Conduit Fields, Kentish Town, Hampstead Road, Camden Town, and forming a junction with the Birmingham Railway; by the back of the Regent's Park, beyond Primrose Hill, the Canal, and Portland Town, to the Edgeware Road, Kilburn, across the Harrow Road and Canal near Kensal Green, joining the Great Western Railway at Kensal New Town, passing behind the Norland Estate, and intersecting the Thames Junction Railway; crossing the Oxford Road near Shepherd's Bush, passing Brook Green and Hammersmith, continuing to North End and Fulham Common Fields, to Walham Green, the Fulham Road, Parson's Green, King's Road, to the Town Meadows opposite Battersea; across the Thames by a Bridge serving for both Road and Railway, passing Battersea through the Fields, forming a junction with the South Western Railway near Piddoes Farm, intersecting the Kingston Road, to Nine Elms; then the Kennington Road and Vauxhall to the Great Central Depôt at the

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Obelisk, where all the present roads from the bridges concentre; thence to the Great Dover Road, to the Croydon, Brighton, and South Eastern Railways, and then uniting the Greenwich Railway at Bermondsey to the Coal Depôts, Dock Yards, and Trade at Deptford: thus completing the continuous line of Railway round the whole of London; communicating with the river at five distinct points, and with additional stations near each leading suburban thoroughfare; every station being, in point of fact, a Terminus, from, or at which, a journey could begin or end.

The combination of the Connecting Railway with the Trunk Railways upon the shore,—the widening of Thames Street—the Floating Piers, &c., are subjects belonging to the embankment and navigation of the river, I therefore propose to bring them forward for consideration in a separate form, as material for other and distinct companies, likely to be even more advantageous and lucrative than the portion above described.

It is now superfluous for me to do more than respectfully urge the consideration of the above described Continuous and Connecting Railway, which affords all the advantages of perfect internal communication, from the facilities of approach to every station, all parts of the Court end of the town being from a mile to a mile and a half, and

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the business portion of the town less than half a mile, of one or the other; thus relieving the centre of the already too great press of traffic, by throwing it towards the extremities, and at the same time greatly increasing the convenience of the suburban districts; besides the vast importance of the central depôt at the Obelisk; and the freedom from the disadvantages of broken lines of communication—of clearing away valuable buildings to form a railway terminus in the heart of the city—and the right which every railway would justly claim to advance its terminus to the seat of business—all which objections are met by such a connecting line as I have laid down.

In conclusion I will merely urge the necessity of proceeding upon some uniform plan, and add the following extracts from the Report of the Railway Termini Commissioners, strongly recommending such a line as I have here described :—

"It is our opinion, supported by the evidence of experienced and very intelligent witnesses, that so far as an easy, unbroken, and economical communication between the northern railways and the docks, or the east of London generally, is concerned, this object can be more conveniently and surely attained by a line which should pass outside the metropolis on the north, at such a distance as to avoid interference with populous

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districts and thronged thoroughfares, and so connect the goods stations of the various railways from west to east with each other, terminating at some convenient point on the Thames or within the docks. Such a railway, it is true, would not bring the merchandise of the north and west so near to the warehouses in the city, as the prolongation of some of the northern lines to Faringdon Street, Aldersgate Street, Fore Street, &c.; but without anticipating the objections which we shall shortly have to make to these projects, it is sufficient to observe that the execution of any, or even of all of them, must still leave the communication with many of the warehousing districts of London very incomplete; and that therefore recourse must still be had to coveyance by cart through some of the most crowded thoroughfares.

"To facilitate the transfer of goods, not only between the northern railways and the commercial parts of London, but between the northern and southern railways respectively, and thereby to make the communication between all parts of the country complete, it would be necessary that the line which we have suggested should cross the river to the west of the metropolis, to connect itself with the South-Western, South-Eastern, and any other lines that may approach the town on that side. The course which it should take has not come specifically under our consideration,

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inasmuch as it would certainly lie beyond the limits laid down in our instructions; but we have no hesitation in saying that such a line might be constructed, answering all the commercial and more important purposes of a central terminus, without being liable to the objections which arise to this latter scheme.

"We have upon this head the valuable testimony of your Majesty's Quartermaster General and of the Inspector General of Fortifications, that whilst it is of the utmost importance, with a view to the national defence, to establish an unbroken connection between the railways of the north, south, and west, a circuitous communication for this purpose round London would, for military purposes, be preferable to one which should necessitate the conveyance of your Majesty's troops or stores through a populous part of the metropolis.

"As to the interruption of important thoroughfares.—We must not dismiss this part of the subject without noticing that which forms a part of several of the projects before us—viz. the carrying a railway across the river within the metropolis. We are of opinion that there are strong reasons for discouraging such a scheme. An increase in the number of bridges already existing cannot take place without creating a new obstruction to the navigation of the river, and

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therefore should not be permitted except on grounds of paramount necessity. To withdraw from ordinary traffic, and to appropriate to the purposes of a railway any of the existing bridges, would be an inconvenience and injury to the public; and no plan which has been brought before us for adapting any of the bridges to both purposes is free from serious practical objections.

"Having now given our opinions upon each railway project which has been brought before us, and the general considerations by which we have been guided in forming these opinions, it only remains for us humbly to submit to your Majesty the following recommendations:—

"1. That on the north of the Thames no railway now before parliament, or projected, be permitted to come within the limits described in our instructions.

"That if at any time hereafter it should be deemed advisable to admit railways within those limits, this should be done in conformity with some general plan, carefully laid down under the authority of your Majesty's government, and sanctioned by the wisdom of parliament; and that under no circumstances should the thoroughfares of the metropolis and the property and comfort of the inhabitants, be surrendered to separate schemes brought forward at different times, and without reference to each other.

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"5. That a communication between the railways approaching London on the north and south sides of the river, and a connection between them and the docks being desirable, this should be effected by a railway encircling the metropolis, crossing the Thames at some point west of Vauxhall Bridge, and not coming within the limits of our inquiry on the north side of the river.

"Whitehall, June 27, 1846.

"(L. S.) CANNING.
"(L. S.) DALHOUSIE.
"(L. S.) JOHN JOHNSON, Mayor.
"(L. S.) J. C. HERRIES.
"(L. S.) J. M. F. SMITH."

THE END.

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Description of the London Connecting Railway, and Railway along the Banks of the Thames.

BY JOHN MARTIN, K.L.

The principal objects of the following Plan were submitted to Her Majesty's Commissioners of Metropolis Improvements, in 1843, but as the subject is becoming of daily increasing interest, I have for greater convenience separated and issued the Plan in its present form.

As it is acknowledged that the various railways leading to the Metropolis require to be connected with one another, and to communicate with the docks and different districts of London, I will endeavour to describe the line I have laid down, and a reference to the map will show that while the railway will go into the very heart of the city, touch every railway both existing and projected, and border closely upon all the populous quarters, yet that these advantages will be effected without encroaching upon private property, injuring vested interests, or interrupting present lines of traffic and communication within the Metropolis.

The following enumeration of the principal places will suffice :—Gallions Reach offering a convenient depot for the Coal Trade, the Railway should commence there at Barking Creek mouth, proceed past Devall's House, through East Ham level, Plaistowe level, across the East India Dock road close to the docks, over the River Lea, and Limehouse Cut at Bromley, Mile End road, near Stratford-le-Bow, and forming a junction with the Eastern Counties and Northern and Eastern

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Railways, joining the Blackwall Railway by a Branch down to Limehouse and the River; past Victoria Park and Bethnell Green, Hackney, Shoreditch, and Hoxton, connecting in its course the Kingsland, Islington, Holloway and Liverpool roads; White Conduit fields, Kentish Town, Hampstead Road, past Camden Town, and forming a junction with the Birmingham Railway; by the back of the Regent's Park, beyond Primrose Hill, the Canal, and Portland Town, to the Edgeware Road, Kilburn, across the Harrow Road and Canal near Kensal Green, joining the Great Western Railway at Kensal New Town, passing behind the Norland Estate, intersecting the Thames Junction Railway; crossing the Oxford Road near Shepherd's Bush, passing Brook Green and Hammersmith, intersecting the Great Western Road at the third milestone, continuing to North End and Fulham Common Fields, to Walham Green, the Fulham Road, Parson's Green, King's Road, to the Town Meadows opposite Battersea; across the Thames by a Bridge serving for both road and Railway, passing Battersea through the fields, forming a junction with the South Western Railway near Piddoes Farm, intersecting the Kingston Road, to Nine Elms, then the Kennington Road and Vauxhall to the Great Central Depôt at the Obelisk, where all the present roads from the bridges concentre; thence to the Great Dover Road, to the Croydon, Brighton, and South Eastern Railways, and then uniting the Greenwich Railway at Bermondsey to the Coal Depôts, Dock Yards, and Trade at Deptford. On the banks of the river the first intimate combination will comprise two trunk railways, one on the north, the other on the south bank of the Thames; the former commencing at Hungerford Market, and following the shores of the river down to Southwark Bridge, then branching off along

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Thames Street, to unite with the Blackwall Railway, or continued to Limehouse as may be hereafter determined: the railway on the latter or south side of the river should commence near the proposed new bridge opposite Chelsea Hospital, and follow the shore of the river down to Deptford Docks, where it would join the main line, thus completing the continuous line of railway along the banks of the river, and round the whole of London, with stations at every populous and convenient locality, one being near each leading suburban thoroughfare.

In addition to a communication by railway on the banks of the river, the mode of effecting the object offers the great and important advantages of uniform embankments, improvement in the navigation, recovered ground, increased wharfage, and a grand public walk and drive easily accessible at every point along the lines, so as to constitute a space of several miles for the healthful recreation of the people. It is proposed to prevent the pollution of the water and air from the numerous drains, by forming a line of intercepting sewers passing behind the different docks, and receiving all the minor drainage in its course; but it is unnecessary to describe these sewers farther, as they form a part of the ultimate district operations of the Metropolitan Sewage Manure Company, of which I am the Projector.

The part of the railway which is upon the shore, would constitute the actual embankment of the river, and the top of the railway would form the public walk and drive along the shore, until it diverges into Thames Street; one side of which should be pulled down and adequately widened, the foundation of the railway being laid in the present level of the street, and the roadway still continued upon the roof, forming altogether a

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commodious and healthful street, as high as the end of London Bridge, and double line of communication.

To preserve the uniformity of the embankment small floating piers should be attached, forming docks allowing the unimpeded flow of the water, and the full advantage of an unbroken line, free from recesses for the accumulation of mud, and from the unsightly and disgusting mouths of sewers and drains.

It is now superfluous for me to do more than respectfully urge the consideration of the above described continuous and connecting railway, which affords all the advantages of perfect internal communication, from the facilities of approach to every station, all parts of the Court end of the town being within from a mile to a mile and a half, and the business portion of the town less than half a mile, of one or the other, thus relieving the centre of the already too great press of traffic, by throwing it towards the extremities, and at the same time greatly increasing the convenience of the suburban districts; besides the vast importance of the central depôt at the Obelisk; and the freedom from the disadvantages of broken lines of communication—of clearing away valuable buildings to form a railway terminus in the heart of the city—and the right which every railway would justly claim to advance its terminus to the seat of business—all which objections are met by such a connecting line as I have laid down.

In conclusion I will merely add, that however desirable may be the complete system, combining the connecting railway with the trunk railways upon the shore, yet that the main objects can be attained by forming the outer connecting line only.

JOHN MARTIN.

30, Allsop Terrace, New Road.
May, 1846.

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METROPOLITAN COMMISSION OF SEWERS
AUG. 20
1849

OBJECTIONS

TO

THE TUNNEL SEWER,

PROPOSED BY

THE METROPOLITAN SEWAGE MANURE COMPANY

BY THEIR NEW BILL:

TOGETHER WITH

AN ALTERNATIVE PLAN,

CONSISTENT WITH THE RECOMMENDATIONS OF THE SELECT COMMITTEE OF THE HOUSE OF COMMONS UPON METROPOLITAN SEWAGE MANURE, 1846;

AND WITH THE

POWERS GIVEN TO THE COMPANY BY THE ACT OF LAST SESSION.

By JOHN MARTIN,

30, ALLSOP TERRACE, NEW ROAD.

1847.

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LETTER

To the Chairman of the Committee appointed to inquire into the merits of the Metropolitan Sewage Manure Bill.

Sir,

It is obviously of the highest importance to effect the objects of diverting the sewage of London from the river, and improving the salubrity of the air of the metropolis, in strict accordance with scientific principles of drainage and ventilation, and the recommendations of the select committee of the House of Commons upon Metropolitan Sewage Manure. As the deep tunnel sewer now proposed by the Metropolitan Sewage Manure Company is an entire departure from the original measure; and the promises held out to the public, to purify the river and air are so entirely lost sight of, that a most careful examination of the new Bill becomes necessary, I beg to suggest the following objections for consideration.

No. 1. The proposed line for the tunnel sewer is stated to be 4720 yards in length, but no mention is made of the numerous sewer and working shafts, which are usually I believe about 100 yards apart. The section indicates two engine and six sewer shafts, but at the datum given forty-two additional smaller sewer and working shafts would be required; the aggregate length of which, at an average depth of 80 feet, would give 3360 feet of sewer and working shafts, more than equal in difficulty of construction, and requiring as much if not greater expenditure in securing a sufficiency of strength to the tunnel itself.

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2. That instead of being a straight line, an ordinary advantage of a tunnel, there are nine angles on the proposed line. It is therefore our duty to inquire, have the additional strength of masonry, which the consequent resistance and friction would require, been duly calculated?

3. The inclination of the sewer is stated to be 10 feet in 4720 yards. The dimensions of the tunnel sewer being so small, would this fall of somewhat less than 4 feet in the mile be sufficient? The commissioners and surveyors of sewers state a fall of from 11 feet to 22 feet to be necessary, large sewers requiring less fall than small ones? Again, whether allowance has been made, in determining the size of the tunnel sewer, for the future accession of sewage consequent upon the rapid extension of buildings now in progress, and on the increased lines of sewers which the commissioners are contracting for in the surrounding districts?

4. Is the 5 feet of clay at the commencement sufficient to support the superincumbent weight of the very worst description of soil, as appears by the following boring,—5 feet soil—7 feet boggy soil—12 feet boggy soil, shingle and sand,—2 feet large stones,—3 feet sand with water—1 foot peat, and 4 feet muddy clay? even if this be granted, the section on examination shows that there will not be 5 clear feet of clay, as the thickness of brickwork, and the space required for working it, but to be afterwards pegged in, are included in the 5 feet given, thus leaving not more than 3 feet of clay to support 60 feet of loose material, and therefore active weight. The experience of practised engineers proves that tunnel works cannot be secure at less than 20 feet beneath the surface of the London clay!

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5. What is the thickness of brickwork to resist this great superincumbent weight?

6. Will it not be requisite to drive the iron sheathing of the shafts right down into the London clay, to prevent the irruption of the running sand and other loose material; and will not this be a great additional expense?

7. Instead of taking the sewers at their outlets, the tunnel line runs at a mean distance of 620 yards from the river, by which much of the richest sewage of a most populous neighbourhood would be entirely lost, and the river itself be still polluted: and further by depriving the lower portion of these sewers of their run, the drainage of the vicinity will be rendered infinitely worse, more offensive, and detrimental to health than at present; a strong argument advanced by Sir James Clark against the first parliamentary plan, and a question for the especial consideration of the Health of Towns Commission.

8. Amongst other advantages of a tunnel sewer, I have heard it advanced, that a conduit of this description would serve to assist in carrying off the drainage in the neighbourhood of the Houses of Parliament. This I hold is next to impossible, as the drainage runs the other way,—and opening any aqueduct into the shaft or the tunnel itself, would become the means of flooding those very portions it is proposed to relieve by its adoption.

9. Is provision made for maintaining the sewage at a low level in time of flood, as represented to parliament? The proposed engine power is stated by the engineers to be only equal to pumping the *entire of the average*, but the surplus flood-water greatly *exceeds the average*, and as there are to be *no reservoirs*, how can it be disposed of

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without additional engine power, which must obviously be great to pump from a depth of nearly 100 feet, and must besides be kept working incessantly night and day every day in the week. If the surplus were allowed to remain stagnant, a great deposit must take place, and when the sewage is so low as to cause a deficient supply to the engines, they would be idle, there would be no longer any flow, and thus *again* a deposit of silt.

10. If the shafts, as required by parliament, be hermetically closed, how is a pressure of 60 feet preserved?

11. The Skew Bridge and White's Bridge sources render it necessary to *pass under the Grosvenor Canal,* and as the tunnel should commence at a depth of 72 feet, and the depth would increase as it proceeds, the construction would need to be most expensive and strong at the entrance of every sewer intercepted; for the fall from such a height, at periods of flood would be like that of a powerful waterfall, which would tear up the bottom, burst, and obstruct all the works. It is erroneous to suppose that the water would disperse in drops and spray, as if it were free; for the body of water being confined, as in a tube, it would, during floods, be the same in volume at the bottom as at the top, the force being in proportion to the height and consequent weight of the column above, increasing with the squares of the distance. The tunnel sewer at the low level stated would silt up, and become the virtual silt well of the sewers, for no system of flushing can operate efficiently, without a free outlet at the lower end; but even if the channel could be kept clear, what adequate means of discharging the certain accumulation of silt at the end of the line are provided?

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12. What is to be done with the running sewage of existing sewers during the cleansing of the tunnel?

13. Only one engine house is represented on the plan,—but will not an engine be necessary at every station for removing the silt? and are such stations likely to be procured or allowed in choice situations, which the intersections of streets usually are?

14. A yet more serious evil than the silt would be the scum that floats upon the surface, which scum being always in a state of active fermentation, evolving volatile and pernicious gases, is the most offensive part of the sewage. The operation of the tunnel will be to back and skim this off! and no provision is made for the removal of the pestilential refuse. This would be a further nuisance added to the silt engine station near Buckingham Palace, and in the other important localities.

15. Will not the numerous shafts necessary for driving the tunnel materially obstruct the thoroughfares? and will not the permanent shafts left along the line be very costly, for if not strongly built, they would be liable to crush in by the passage of heavy traffic in the road above?

16. What provision is there for ventilating the sewers, as promised to parliament, without which the air of the district will be left in a worse condition than at present?

17. The tunnel would have to be carried for a whole mile at its maximum depth, before it reaches a sufficient body of sewage for experiment; all that it intercepts between the station at Stanley Bridge and Robert Street, being little otherwise than land drainage.

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18. Is it not desirable that the first works should be so effectually and permanently executed as to require no future return to the same ground?

19. Would it not be advisable to proceed with present powers, and to expend money in gaining consents, in preference to spending it in supporting a new bill?

20. What is the feeling of the Governors of Chelsea Hospital, Mr. Brett, the Marquis of Westminster, Mr. Sloane Stanley, Mr. Wyse, Mr. Cubitt, and other influential proprietors on the line of the tunnel?

21. Although we may admit the feasibility of forming a tunnel sewer at the depth stated, and even agree in the practicability of accomplishing *all* the desired objects, yet it can only be by an enormous outlay. Are the estimates of the engineers anything like commensurate with the practical difficulties and exigencies they will have to en-

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ment of the station, and one or two other points of minor importance.

25. Is the station at Stanley Bridge the most suitable and advantageous for the purposes required ?

In advancing the foregoing objections, I am fully prepared to submit an alternative measure, which I am satisfied could be realized by the powers given in the act of last session.

I have the honor to be,

SIR,

Your obedient Servant,

JOHN MARTIN.

30, Allsop Terrace, New Road,
February 17th, 1847.

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PLAN

For diverting the Sewage of the Western Division of the Westminster District from the Thames.

THE further consideration which I have given to the plans of the engineers, for diverting the sewage, leads me to conclude that the various errors I have had occasion to point out, have arisen in deficient knowledge of the true principles of drainage, without which knowledge, a proper plan cannot be formed. It appears to me, that hitherto, sufficient distinction has not been drawn between land drainage and town drainage, the principles of which are diametrically opposed—the operation of the first being to leave every impurity behind in the soil, the drain itself running only pure water; whereas, in the last, all moderately fluid refuse should be discharged into the drain, which would continue to increase in impurity as it progresses: thus, land drainage in reality terminates where town drainage begins, the perfection of the one being, that it must be entirely free from all pollution, whilst the other cannot be too gross and impure at the outlet. All the principal sewers, however, are, at the commencement merely land drains; running, at first, pure water, but gradually becoming polluted by the sewage of houses here and there, and so on as population increases, until it enters the body of the town, where the pollution is augmented by numerous tributaries consisting only of sewage, nor does it attain its greatest degree of pollution till it reaches the

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river into which it is discharged.—It is clear, therefore, that the lowest portion of the sewer, which is surrounded by the densest population, must be worth all the rest put together, and that the higher we go up, the less of the fertilizing matter do we divert, whilst we carry off the land drainage which is so indispensable in giving a flow to the sewers below, although altogether valueless as *manure*. King's Scholar's Pond Sewer, and the Ranelagh Sewer, are exactly as I describe;—they arise in land springs in the hills near Hampstead—run through the fields receiving the drainage of a few scattered houses, until they reach London itself, where they gradually swell and gather fertilizing material till they reach the Thames.

In the full conviction that there was no other practicable mode of giving effect to these principles, and accomplishing all the various objects originally promised, than by intercepting the sewers at the *lowest* level, namely, their *outlets at the river*, I urged the necessity of carrying the intercepting sewer, or main pipe from the *outlets* of the sewers along the shore of the river, and between high and low water mark; and the Report of the Select Committee of the House of Commons confirmed and recommended this view of the case. The represented refusal, however, of the Navigation Committee to allow the main pipe to be laid in the bed of the river, led me to consider whether a line might not be adopted, which would effect all the objects promised to Parliament, in their full integrity, without exciting any reasonable opposition. The following is the alternative proposal.—

I recommend taking up King's Scholar's Pond Sewer by means of an efficient sewer at Brewer Street, carrying the sewer down Lower Belgrave Place, Upper Belgrave

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Place, Belgrave Terrace, Bridge Row, down Commercial Road, and there effecting the junction with the Ranelagh Sewer, proceeding along which to the river, and then by an intercepting sewer in the shore line towards the outlet of the Kensington Canal, which is on the same level as the outlet of King's Scholar's Pond Sewer. The lower part of King's Scholar's Pond Sewer, and the sewers of the parliamentary district, would form a second division to be effected hereafter.

ADVANTAGES OF THIS NEW LINE.

No. 1. The line, including the 1700 yards of intercepting sewer, is only 3500 yards in length, is unbroken and direct, and moreover terminates in the centre of a district where a supply would be in immediate demand, 1000 acres of nursery and market garden ground being on the London side of the Kensington Canal.—Thus a branch might be sent out at but a few yards from the divergence of the main.

2. 1800 yards of the sewer are already formed, only requiring their bases to be lowered, and the liberal desire which the Commissioners of Sewers have always expressed towards furthering this measure, on public grounds, warrants an anticipation of their agreeing, which would give the required consents for half the distance.

3. There would be only 1700 yards of new intercepting sewer to form, the requisite consents for which comprehend a few private parties and the Embankment or Roads Commissioners.

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4. There would be a choice of three favourable situations for the engine station, each immediately adjoining the river.

5. Greater fall would be obtained for the sewer, which can be maintained at a high level throughout (a great desideratum in drainage) so that there would be no difficulty from deep underground works.

6. All the existing outlets of sewers would be improved by the proposed means of letting off the flood waters, and excluding unusually high tides.

7. The main body of the sewage of King's Scholar's Pond Sewer, and all the sewers and even small drains between it and the Ranelagh, and between the Ranelagh and the station, would be *entirely intercepted*, thus effecting the object of *completely diverting* pollution from the river, and perfecting the drainage and ventilation of the Palace and Pimlico districts.

8. The superabundant flood waters of King's Scholar's Pond Sewer would be let off into the old channel, and the drainage of the district would always be kept down.

9. No station for removing the silt would be required in the district, as the sewer would relieve itself by its easy communication with the river: the silt being raised at the end of the line by the dredging machine formerly described.

10. The whole district, including the entire vicinity of the Palace, would be effectually and easily trapped and ventilated, and thus the air preserved from pollution by the exhalations from the sewers.

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By commencing at Brewer Street the great engineering difficulty of passing under the Grosvenor Canal would be avoided, besides that the canal runs so nearly parallel with the works, that it would work with the river in affording the advantages and saving of water carriage for materials.

As the sewer has to be worked from the engine station, and the first half mile intercepts three considerable sewers consisting entirely of sewage, namely, Milman Row, Church Street and Queen Street Sewers, and several minor drains *at their outlets;* experiments might be commenced at once with the body of sewage obtained at only 340 yards distance, and the portion so executed would, in the short space included, efficiently and completely accomplish the object proposed. This part of the intercepting sewer, after taking up the Queen Street Sewer, might either go direct to the mouth of the Ranelagh Sewer, or along Paradise Row, effecting the junction at Grosvenor Row.

The Ranelagh Sewer to be covered in, and the proposal would consequently be supported by the Chelsea Hospital, and Mr. Brett, who promised £1000 towards covering in that sewer.

The Chelsea Water Company would not be obstructed, as the line passes above their works.

All the objects promised to parliament would be efficiently realized.

That a proposal should be made to the Commissioners of Sewers, to make the requisite alteration in the sewers, upon the company undertaking to pay the expense.

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That the Commissioners of Sewers would by these means retain control over the sewers down to their outlets at the river, whilst the Company need be under no apprehension as to the future diversion of the sewers, as the Commissioners could not obtain a more favorable point of discharge.

That the line is dependant upon few consents beyond the Commissioners of Sewers, and Metropolis Roads.

That if the first works are executed in the most efficient manner, the Company would secure support and sanction for its future proceedings; but if, on the other hand, the works are inadequate, the Commissioners of Metropolis Improvement and Health of Towns, as well as the Government, may be expected to interfere and prevent the extension of the Company.

The lower part of King's Scholar's Pond Sewer and the Sewers of the Parliamentary district should be treated as follows.—To continue the sewer from Wood Street to the outlet of King's Scholar's Pond Sewer, and thence to carry a large main directly across the river to where the Effra Sewer disembogues. At this point the engine station should be, as it possesses the additional advantage of giving us a position whenever we may take up the Effra Sewer, one station thus serving for two districts, whilst there would be no engine for *this* division of the sewage on the Middlesex side of the water. This appears to be the readiest mode of carrying off the sewage of the parliamentary district; which would, likewise, thus be the cheapest we should have to effect; for the distribution could commence almost immediately from the station, and less than half a mile from the outlet of King's Scholar's Pond Sewer.

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In conclusion, I would urge that no obstacle should be placed in the way of an object of so much importance—an object which combines the advantages of not only preventing waste, but of rendering the labour and money expended remunerative. Those then who impede such a measure it is scarcely too much to regard as enemies to their country. Let the exigencies of the present time, when food is scarce, and the increasing population starving before us, influence those who have hitherto obstructed this project from doubts which Government Commissioners and Parliamentary Committees must have now entirely set at rest, and induce them to follow the noble example of the Marquis of Westminster, Lord Robert Grosvenor, and other enlightened gentlemen, in promoting an object daily augmenting in vital consequences. The Government itself has already suggested, and is commencing a system of remunerative labour in Ireland, and though the principle is not new either in theory or practice in England, it cannot be said to be really carried out, whilst so great a mine for increasing the produce of the land is left unworked.

JOHN MARTIN.

30, Allsop Terrace, New Road,
February, 1847.

PRINTED BY J. PLUMMER, PUDDING LANE, EASTCHEAP.

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METROPOLITAN COMMISSION OF SEWERS
AUG 20 1849

THAMES AND METROPOLIS IMPROVEMENT PLAN:

BY

JOHN MARTIN, K. L.

THE SECOND DIVISION,

SUPPLY OF PURE WATER TO THE METROPOLIS.

THIS PLAN EMBRACES THE FOLLOWING ADVANTAGES:

1. AN INEXHAUSTIBLE AND UNINTERMITTENT SUPPLY OF PURE WATER TO LONDON.
2. A SUPPLY OF SEWAGE MANURE TO THE COUNTRY.
3. THE IMPROVED NAVIGATION AND INCREASED BEAUTY OF THE THAMES.
4. AN IMPROVED SYSTEM OF INLAND DRAINAGE.
5. THE MELIORATION OF THE HEALTH OF THE INHABITANTS OF THE METROPOLIS, AND OF THE COUNTRY DISTRICTS, BY THE REMOVAL OF EXISTING SOURCES OF DISEASE.

THE THIRD DIVISION CONTAINS

A PLAN FOR IMPROVING THAMES STREET.

A PLAN FOR REMODELLING WESTMINSTER BRIDGE,

THE MODE OF CONSTRUCTION BEING EQUALLY APPLICABLE TO EITHER THE NEW CHELSEA, BATTERSEA, OR PUTNEY BRIDGES.

MEANS OF CONNECTING THE PORT OF LONDON WITH THE INLAND RAILWAYS.

TOGETHER WITH

DESCRIPTION OF MARTIN'S PATENT WATER AND SEWER PIPES, PATENT DRAIN TRAPS AND SEWER OUTLETS, AND MEANS OF CONSUMING SMOKE.

LONDON:—LINDSEY HOUSE, CHELSEA,
1849.

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PLANS DEVISED AND PUBLISHED BY MR. MARTIN.

PLAN FOR SUPPLYING THE CITIES OF LONDON AND WESTMINSTER WITH PURE WATER FROM THE RIVER COLNE;—containing, likewise, the details of a Proposition for securing the Thames from the admission of the Sewage, and rendering it available as Manure.

With numerous Plates.——*London*, 1828.

OUTLINES OF SEVERAL NEW INVENTIONS—namely:

1. Elastic Iron Ship.
2. New principle of Steam Navigation.
3. Elastic Chain Cable.
4. Coast Lights on a new construction.
5. Plan for Purifying the Air, and preventing explosions in Coal Mines.
6. Second Plan for supplying London with a purer Water, by a Weir across the Thames near Chelsea.
7. Plan for more effectually Draining certain Marshy Lands contiguous to the Thames.

With numerous Plates.——*London*, 1829.

PLAN FOR IMPROVING THE AIR AND WATER OF THE METROPOLIS, by preventing the Sewage being conveyed into the Thames (by means of parallel Sewers) and for using the Manure for Agricultural purposes.

With numerous large Plates.——*London*, 1832.

PLAN FOR SUPPLYING LONDON WITH WATER FROM THE COLNE, combining a Railway, and new construction of Rail.

With large Plate.——*London*, 1834.

PLAN FOR AN IMPROVED SYSTEM OF INLAND DRAINAGE.

With Plate.——*London*, 1834.

PLAN FOR WORKING AND VENTILATING COAL MINES.

Two Plates.——*London*, 1835.

THAMES AND METROPOLIS IMPROVEMENT PLAN.—The objects being, To supply the Metropolis with Pure Water.—To embank the River Thames, and preserve the Sewage.—To improve the Navigation below London Bridge.—And to connect the Port of London with the Inland Railways.

Numerous Plates.——*London*, 1842.

PLAN OF LONDON CONNECTING RAILWAY.

With Maps.——*London*, 1845 & 1846.

THAMES AND METROPOLIS IMPROVEMENT PLAN (Sewage portion distinct.)

London, 1846.

OBJECTIONS TO THE TUNNEL SEWER, proposed by The Metropolitan Sewage Manure Company by their New Bill: suggesting instead an Alternative Line.

Numerous large Plates.——*London*, 1847.

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THAMES AND METROPOLIS IMPROVEMENT PLAN;

THE OBJECTS BEING

TO IMPROVE THE DRAINAGE AND AIR OF THE METROPOLIS, AND TO PRESERVE THE SEWAGE FOR AGRICULTURAL PURPOSES.

TO AFFORD TO THE METROPOLIS AN UNFAILING SUPPLY OF PURE WATER.

TO EMBANK THE RIVER AND IMPROVE THE NAVIGATION.

TO DRAIN THE COUNTRY DISTRICTS, AND PRESERVE THE PURITY OF NATURAL SPRINGS AND STREAMS.

AND TO CONNECT THE PORT OF LONDON WITH THE INLAND RAILWAYS.

SECOND DIVISION.

Plan for supplying LONDON with the pure Water of the Thames, unmixed with the foul drainage; and for improving the salubrity, the beauty, and the navigation of the River above the point of supply.

THE subjects of drainage, ventilation, and supply of water are now so inseparably associated in the public mind, that I have no hesitation in selecting the present time for urging that division of my Thames and Metropolis Improvement Plan which comprehends the supply of water, and its immediate and necessary connection with the diversion of the Sewage from the River; the mode of effecting which, and applying the manure to agricultural purposes, is described in the first division of the general plan already published.

The objects of this second division are—to give an abundant supply of water to each house from the lowest to

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the highest levels, without employing steam engines;—to derive the supply at the distance of only one mile and a quarter from Hyde Park Corner;—to separate from the stream the tidal water and filthy drainage of London, and the adjacent towns and villages, so that even in time of flood, the water shall enter the pipes in a perfectly bright and pure state;—to form public Baths, and afford running Fountains to the ornamental lakes in the public parks, leaving no stagnant waters or reservoirs in the Metropolis;—to remove the nuisance of smoking engines;—and finally, to permanently improve the salubrity, beauty, and navigation of the River, and increase the value of the property upon its banks.

Much as the question of a copious supply of pure soft water to the Metropolis has been agitated, and considerable as have been the improvements within the last 20 years, yet the great object of an unlimited supply of perfectly pure water has never hitherto been definitively attained. The existing companies declare that they cannot afford an unintermittent supply without an outlay that is tantamount to rendering the works impossible:—to derive the supply from distant sources, even if adequate in quantity, is not only enormously expensive, but is depriving such distant districts of the waters which properly belong to them:—and the alternative of sinking Artesian Wells is obviously impracticable for so extended a purpose, if we may judge from the experiments of many individuals—the facts that the wells at Watford are ascertained to be higher on Monday mornings than they are on those other days of the week when the breweries work their wells—and from the signal failure of the attempt made by the Chelsea Company in 1826. Notwithstanding the favorable situation of the works (the lowest level on the banks of the Thames) the result of this experiment was, that after boring 200 feet into

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the chalk, which was 240 feet from the surface, only 200,000 gallons of water in 24 hours were obtained from three bore holes of 6 inches in diameter, the quantity stated in the House of Commons Report of 1834 to be daily consumed in the Metropolis, being upwards of 33,000,000 of gallons! The engineer, in consequence of this trial, and of extensive enquiries from others who had introduced boring on a large scale, reported the case hopeless for any thing like the purpose required, as "generally speaking, for one bore hole which had succeeded round London, another had not succeeded; the supply as far as his observation had gone, having been continually decreasing." In addition to this, is an objection raised by the late Mr. Buddle, the eminent coal viewer, that even supposing the quantity attainable, the abstraction of so much water would endanger London, there being no means of leaving pillars and props, as in coal mines, to support the superincumbent strata. After a careful and mature consideration of all these facts, and of the merits of every proposal which has been advanced by myself and others, I have, at length, arrived at the unequivocal conclusions that—the Thames is the only source whence a sufficient quantity of water to meet the increasing requirements of the Metropolis can be permanently obtained;—and that for this end the point of supply must be from the united body of the stream, and near to London, in order to obviate that interruption of the navigation, which would infallibly occur by abstracting the water higher up, or from the rivers and springs contributing to its flow. The objection, however, to deriving a supply from any low point, is the difficulty of preserving the purity of the main stream, from the tidal and sewage waters which at present pollute it; and this difficulty I propose to meet by the following plan, which combines many objects of the highest importance to the sanitary condition, not only of the Me-

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tropolis and its vicinity, but of every town and village in the united kingdom where its general principles can be applied.

That part of the river Thames which lies between the Chelsea water-works on the one shore, and the Southwark water-works on the other, appearing to be the best adapted to afford a permanently adequate supply of water without injury to existing demands or interests, I would there construct across the stream a weir as high as mean high water mark, with a side channel connected with the river above and below the weir, and having self-acting valves to back the water in spring tides, and let off the superabundant waters in time of flood. As there would be a fall of the whole body of the Thames over this weir, of 16 feet, for 16 hours a day, this immense natural power should be applied to working water wheels and pumps, thus saving a vast amount of steam power and nuisance from smoke, and enabling the different companies on both sides of the river to derive from this one point, an unvarying high pressure supply without the aid of steam engines. In order that the water should at all times enter the pumps perfectly clear, without using settling or other reservoirs, it should be taken from the upper bed, having first passed through filtering strainers of double horse hair, with sand between, and then be raised by the pumps with self-adjusting tide wheels, and Hague's vacuum engine, to a hydraulic tower, for supplying the various levels on both sides of the river. The main pipes from the tower should be connected with the feeding mains of the Chelsea and Southwark companies, and from thence with the mains of the other companies, the pressure upon the pipes keeping up a constant supply of water to the highest points of the various districts.

The following diagrams elucidate the above details.

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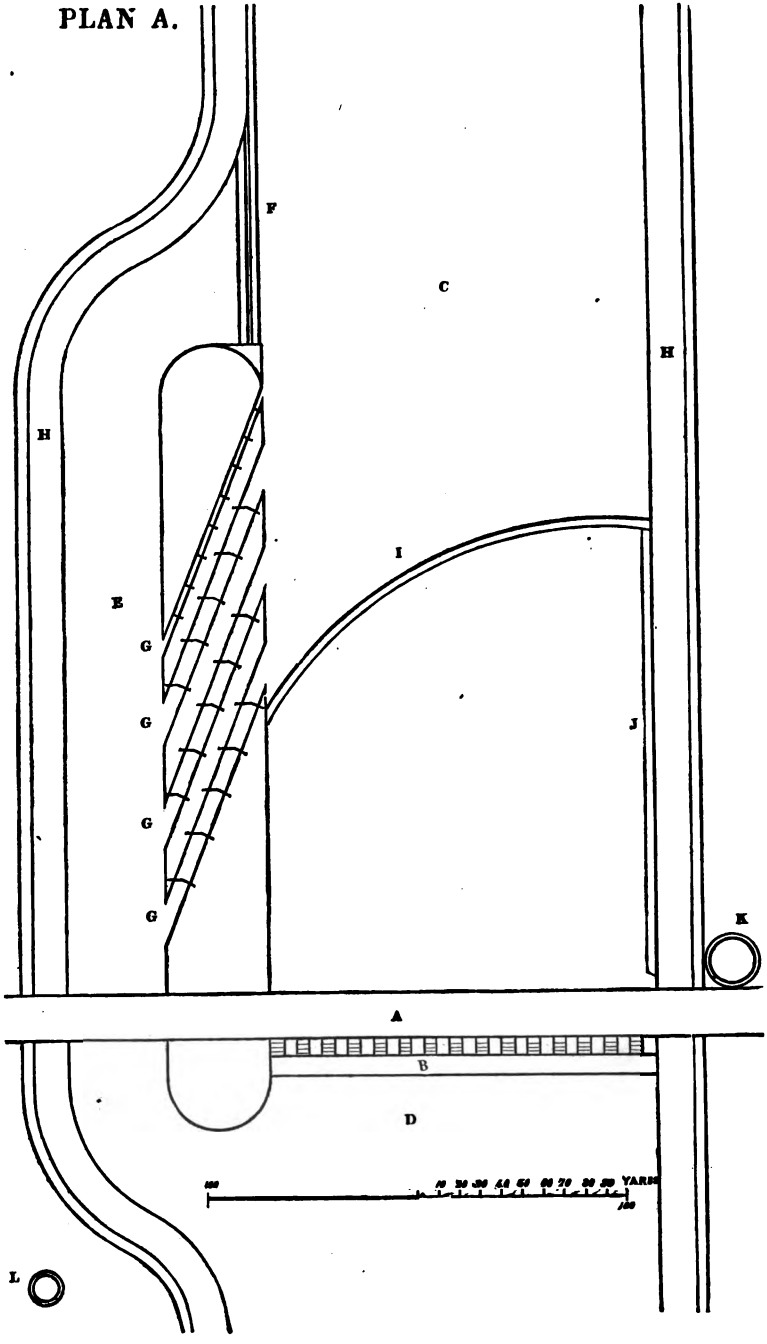

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PLAN A.

GROUND PLAN OF BRIDGE, WEIR, AND LOCKS.

A The weir serving also as a bridge.

B Self adjusting platform, with tide wheels.

C The river above the weir; to maintain the water in that perfectly pure state requisite for domestic purposes, the whole of the sewage above this point should be diverted, and the water thus rendered available for the supply of London.

D The foul water below the weir.

E Channel by which superabundant flood waters would escape.

F Self-acting valves to let off the superabundant waters in time of flood, and to keep back any extraordinary high tide, which would otherwise enter and pollute the waters above.

G Locks of various capacities adapted to craft from the largest to the smallest size, as the whole might be working at the same time; or, if only one small boat needed to pass, one gate of the small lock would enable it to do so, without the loss of time consequent on filling the large or entire basin. These locks being placed between the side channel and the main body of the stream, the weir would occupy the entire width of the river, and neither space nor power be lost.

H The embanked roadway.

I Break Barrier to prevent ice, or extraneous substances entering and clogging the action of the wheels.

J Horse-hair Strainers to filter the water before it enters the pump well of the engine.

K Pump well of engines for water supply.

L Pump well of engine for sewage supply. This well should be divided into two equal parts, the one to receive the unmixed sewage, and the other water to dilute it before transmission through the mains to the country district, so that either water, sewage, or both mixed, could be sent according to demand.

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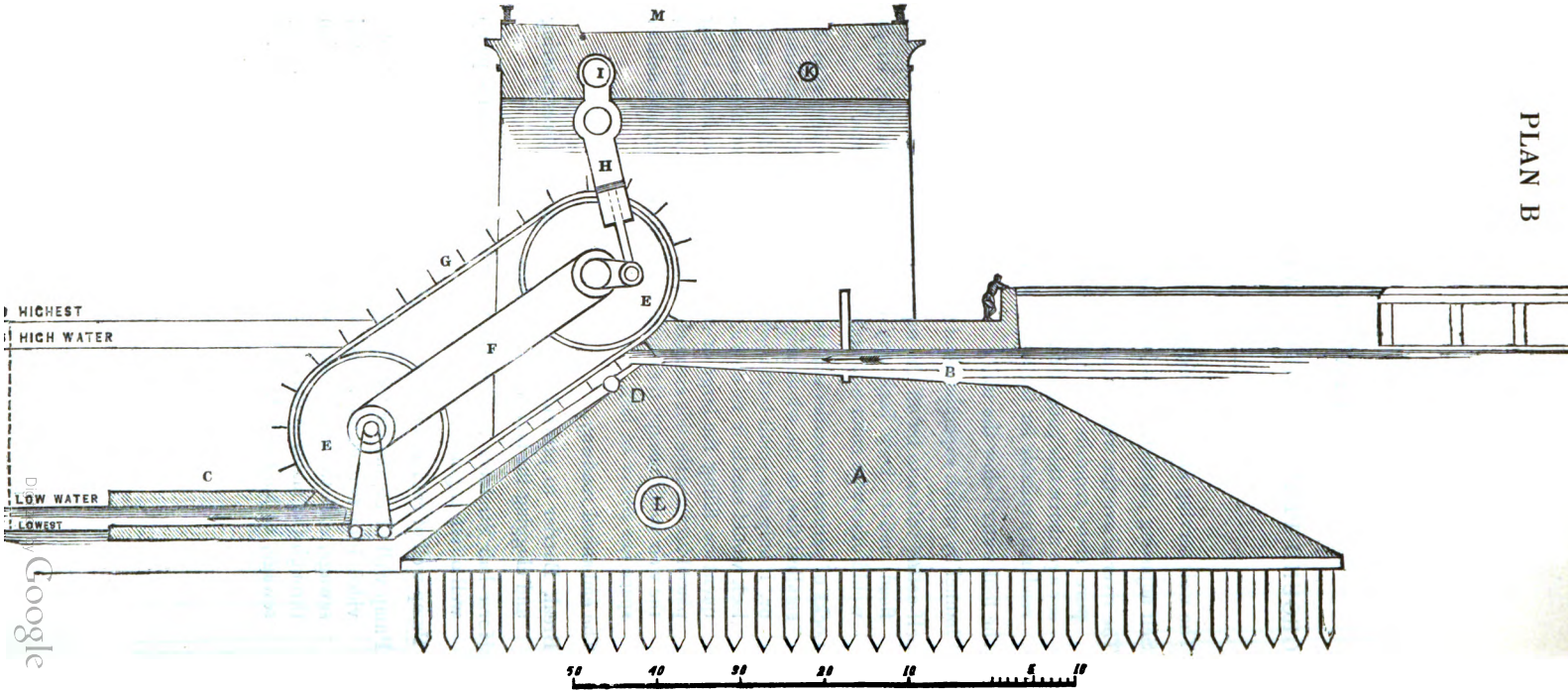
PLAN B



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PLAN B.

Self-adjusting Tide Wheel, which possesses the advantage of continuous power without the loss from tail water, caused by the immersion of the Float Boards. It consists of two wheels connected at a given distance by a strong unyielding beam: an endless Metal Band with float boards at regular intervals, extends round and joins the two wheels, the upper of which is maintained in a fixed position, whilst the lower rises and falls as the tide raises or lowers the floating platform upon which it rests, thus preventing the immersion of the float boards, which will invariably retain the same position relatively to the water. The downward pressure of the stream will act severally and conjointly on the whole range of floats as they are brought within the force of the current, until they rise out of the stream, passing through the trough of the platform. By this disposition of the Floats, if one be supposed to move with a force equal to 10, a range of ten Floats will give a force of 100, securing the hitherto unattained advantage of power equal to a large wheel, with the increased velocity of a small one.

A Section of Weir.

B Channel for the Water.

C Self-adjusting Platform and Trough for each wheel.

D Hinge of Platform.

E The double Wheel.

F The Connecting Beam.

G The Metal Band and Float Boards.

H The Pump.

I Vacuum Pipe.

K Water Pipe.

L Sewage Pipe.

M Roadway of Bridge.

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There being a cessation of power for about two hours of each tide, it will be desirable to meet this by placing hydraulic towers on certain heights, such as Camden Hill, Barrow Hill, Pentonville, and on the Surrey side, Knight's Hill; as these hills being already high, little additional altitude would be required; but wherever there are stand pipes at present, they should be enclosed in brickwork of sufficient strength to support a capacious cistern on the top for the purpose of receiving the water which would be pumped during the night when there is little consumption: in this way the head of water requisite for pressure would always be maintained without any waste of power. To complete the works, the banks of the upper part of the river should be raised where they may require it, and wherever soft and earthy, faced with slate planking--a sufficient towing path made on the right, and foot-path on the left bank to unite with the embankment at London, forming a continuous walk from Twickenham to the Tower; and as the weir itself would furnish the foundation for the new Chelsea Bridge, the separate objects would all combine together in one general system. As the point indicated for the weir is below the entrance of the Grosvenor canal, I propose to remove the locks, to enlarge the canal itself, and to form a new entrance channel into which the water from above the weir should enter freely. There being a difference of 16 feet between the upper and lower levels at the weir, it would be easy to secure a constant change of water, and scour of the canal, by laying a pipe from the basin towards the lake in Buckingham Palace garden, whence the waters should finally discharge through the lake in St. James's park, maintaining a continuous natural run, and affording the power of flushing the King's Scholars Pond and other sewers with fresh water at any time. Thus the health of the entire district would be improved, and by

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forming gardens of the whole of the waste and unoccupied ground between the canal and Chelsea Hospital, and giving a semicircular turn to the road connecting Sloane Street with the Bridge, a noble crescent facing the south west might be formed to the profit of the proprietors. and advantage of the public. The tide and foul drainage below the weir being separated from the water above, and the refuse of the numerous factories, mineral and gas works, and all the sewage of the western suburban districts likewise diverted, the River would be permanently secured as an inexhaustible reservoir of wholesome running water, and the whole of the fertilizing manure would be rescued from worse than waste; whilst the navigation would be vastly improved, as the stream would be rendered sufficiently deep to be at all times navigable by those larger vessels now detained for hours every tide, the Richmond steamers even being constantly grounded in the summer season. In support of this last recommendation, I have the favorable testimony of different practical men, who concur in the advantage of thus backing the water, and amongst others of the late Mr. Leech, the river surveyor, who was opposed to my early plan, suggesting a weir between Battersea and Vauxhall, upon the ground of obstructing the traffic, but who subsequently expressed to me his change of opinion, and conviction, that instead of impeding, it would greatly improve the navigation; and unquestionably all must see that the uniform embankments and invariable high water would augment the value of the property, and the beauty of the residences and walks upon the shores of the river. The proposal is also entirely free from the objections which attach to plans deriving the supply at a higher level; or from the Colne or other tributaries, such as compensation for mills,—the cost of conduits from the source of supply to the Metropolis,—and the already mentioned

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incalculable injury to the river Thames, consequent upon abstracting so much water as would be required for the consumption of the Metropolis, from a high point, or from any of the intervening tributary streams. As regards the compensation for mills.—Mr. Telford's estimate in 1834, for his Verulam Plan was £224,314, and for the Wandle £150,095; but according to Mr. Anderson, the Colne alone would require £450,000 compensation for mill property. Then the cost of conduits would at a moderate computation be £20,000 a mile, exclusive of the expense of the requisite tunnelling, embanking, and compensation for land upon the line: but the most important consideration of all, is the injury to the Thames itself between Henley and London, both as to its beauty, and its utility as a navigable river. According to the evidence of Mr. Payne, clerk to the Conservancy Commissioners, whose jurisdiction extends from Staines to the source of the Thames,—so deficient is the quantity of water above Maidenhead in dry seasons, that the Commissioners have a discretionary power to limit the depths at which barges may pass, namely to 3 feet, when they ordinarily travel 4 feet:—that there never is any surplus water excepting in floods:—and that there is no period when even "400 cubic feet in a month" could be abstracted from the navigation!—How much then would all such places as Windsor, Richmond, and other lovely scenes and populous places, constantly suffering from this cause, be farther injured by abstracting from their already deficient streams; and on the other hand, how greatly would their beauty be enhanced, and how many advantages would they derive by adopting the foregoing suggestions.

Although the advantages above enumerated might in themselves be esteemed a sufficient recommendation of this plan, its financial superiority in other points is so clear as to establish the correctness of my calculation, that so large

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will be the amount in recovered property and machinery; and in the annual expense of maintaining the steam power, as to be fully commensurate with any reasonable estimate for works that may be formed. In the first place, the substitution of water power for steam engines, is alone a most important item, as we are informed that in the great water works at Philadelphia, wheels have superseded steam engines, yielding twice the quantity of water at a cost of exactly one tenth; and that here in London the Grand Junction Water Works Company had alone expended down to September 1833, no less a sum than £127,260 upon engines, engine houses, reservoirs, and the value of land for their formation. Other companies, it is known, have proportionate expenditure; and exclusive of the money so sunk, Mr. James Simpson, the Engineer of the Chelsea Company, has stated in the before mentioned Report upon Water Supply, 1834, that the annual expense of maintaining an engine power equal to raising 100 cubic feet a second 60 feet high, or at an average altitude of 120 feet, would be at least £25,000 a year: but to raise such a body of water to higher levels, or to a uniform elevation of 120 feet, the expense would be enormously greater, as the following extract from Mr. Mills evidence in the same Report will show. "The actual expense of pumping 3½ feet per second, or 288,048 feet per day, is stated in the Parliamentary Report of 1821, by the West Middlesex Company, to be £3,150 per year, about £1000 per cubic foot for water pumped 136 feet high. The actual expense of pumping 3½ cubic per second, or 310,000 feet per day, is stated in the same Report by the Grand Junction Company to be £3,500 per year, equal to £1000 per cubic foot per second for water pumped 115 feet high. The expense in the same Report by the New River Engineer, for pumping 18½ cubic feet per second, 84 feet high, is stated to be £16,000 per year,

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which would amount to £1400 per cubic foot per second for an elevation of 120 feet." "The quantities supplied by the companies was stated by them to be 69 $\frac{6}{10}$ cubic feet, proposed to be raised to 103 feet per second. Now it is manifest, that if the above calculations are correct, that to pump the present supply on the north side of London will cost £18,500 per year, and to pump the supply at the south £9,100 a year, making the present cost £27,600 per year, and that to increase the present supply by pumping to 43 feet, would require an endless expense of £43,000, equal to 4 per cent. on a capital of £1,075,000. It is also clearly proved that the present New River, even if the water could be conveyed in a pure state, cannot yield more than half the present supply for their district and the East London; and that to pump 42 feet per second would cost £42,000 a year, equal at 4 per cent. to a capital of £1,050,000; and that to increase their present supply, by pumping to 60 feet, would cost £60,000 for pumping alone, 4 per cent. on £1,500,000," making £103,000 a year for pumping.

The whole of this enormous annual expense would be saved by the substitution of the water power, which should be used to the fullest extent; nevertheless it would not be advisable to remove all the existing steam engines, as many of them are in situations peculiarly advantageous for diverting the sewage, and engines worked by fire being necessary to consume the foul air in the drains, these might at once be applied to raising and forcing the manure into the country. This constitutes the second great advantage of the plan, for not only would one set of engines be rendered unnecessary, but in turning them out of use for one purpose, they are immediately ready for application to another, without incurring any expense whatsoever, whilst the sale of the surplus engines would raise capital to invest in the new works. Then again, the source of supply being close to London,

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the great mains from the present suction points of the Grand Junction and West Middlesex Water Companies to their London Reservoirs, would no longer be needed for conveying the water, and could consequently be appropriated to the transmission of the sewage, effecting the saving of many miles of large main from the respective feeding points at Brentford and Barnes to the town reservoirs, and the accompanying cost and nuisance of opening the ground and laying fresh pipes; the sewer water could be carried off without delay, the entire apparatus, including the small reservoirs applicable to the covered manure depôts, being already provided in the most desirable situations, and all convertible to their new use with very little expenditure: next, the river above the weir being an inexhaustible reservoir of pure running water, the settling, filtering, and other reservoirs would be unnecessary, by which many acres of ground, in situations of great value for building purposes, would be recovered: there would be an unlimited supply of pure soft water from one single, instead of from six separate points; no fresh pipes would need to be laid down, as the water could at once be projected from this single feeding point into the mains and services of the existing companies: the companies would require no additional capital, as the proceeds from their present plant would cover the additional expenditure; the bridge so much required must be at this spot, and as the weir combines with it the construction of a bridge, the two objects may obviously work together: and finally, the point indicated appears to be the very best for advantageously diverting the sewage of the Westminster district.

The foregoing plan has reference only to the six companies that derive their supply from the Thames; the New River, and the East London Companies, having entirely independent sources; but inasmuch as it is stated in the

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Report of the Health of Towns Commission, 1845, that the New River only supplies two-thirds of its complement of population, it is proposed to discharge into its mains the required additional quantity to enable it to afford an uninterrmittent supply. Nevertheless these two companies might be rendered independent of such aid, by applying the foregoing plan to the river Lea, constructing the weir as low down as practicable: the river Ravensbourne might be similarly backed; and, indeed, I would strongly recommend that this means of gaining water power should be applied to all rivers acted upon by the tide; as the action of the tide alone is used with advantage in some places by means of side cuts; but in running streams, in addition to the occasional tidal power, there is the constant power of the descending current. This power in the Thames, even above the tidal action, is most important, for there are six locks between Teddington and Staines, at each of which water power could economically be gained by my new wheel, and transferred by the vacuum engine to any point.

It is not necessary here to do more than revert to my early proposal for diverting the sewage from the Serpentine, and for supplying pure water to that and the other ornamental lakes in the Parks, by conduits from the Gutchwell Spring, or Garrett's Mill, or by Artesian Wells. Suffice it that the recommendation, in my plan of 1828, led to the diversion of the Bayswater Sewer, but by means so injudicious and inadequate to the extension of building then and now going on, that the flood water and sewage have again overflowed, and rendered the Serpentine, as much as ever, a stagnant receptacle for foul sewer water. This has recently been partially remedied by giving a more easy turn to the sewer, but ere long it will be found requisite to provide further accommodation for the drainage; and I, therefore, again urge my first suggestion to carry off the sewage of the Bayswater

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district by a small sewer or pipe, running in or parallel with the bank of the Serpentine, and discharging into the Ranelagh Sewer near Knightsbridge. The sewage having been diverted, the next measure should be to drain off the foul waters, by opening the centre sluice at the lower end of the Serpentine; and then to level the bed, and lessen the general depth of the river, so that the deepest part may not exceed five feet. To effect this, the depth at the shore, and where the bed is too shallow, should be increased to four feet, and the material thence removed employed to fill up the numerous deep holes and inequalities in the centre; the whole then be covered with clean gravel, which abounds in the neighbourhood, through which the springs in the bed would rise freely, and contribute to the main stream; and finally, the banks should be lined with slate planking, to preserve them from washing up. It would farther be advisable for the surface of the water of the lake fronting Kensington palace to be three feet lower than it is at present, in order to improve the drainage, and render the banks more dry and agreeable, the bed and sides being treated in the way already described for improving the Serpentine. As regards the water to be supplied instead of the notoriously foul water which now enters, it must be evident that the Thames in a pure state as shown above, would answer every purpose required; but in accordance with my opinion that ornamental waters should be from independent sources, entering freely without the aid of engines, I prefer recommending obtaining the supply by boring, for the soil indicates that at no great depth springs would be found like those at Garratt's Mill, &c. near Wimbledon Park, which rush up with immense force, after boring 130 feet, yielding 30 cubic feet of water per minute. It is only reasonable to infer that where the water forces itself up naturally in such abundance, as it does in and near the Serpentine, the ground

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will be favourable for the Artesian supply, especially when we know that the conduits at Paddington, which anciently supplied London with water, were close to the head of the Serpentine, and are still to be found under the gardens of Westbourne Terrace, or Conduit Street West, two springs on Craven Hill having only within the last few weeks been covered in:—these springs it should be remembered are public property, and no private parties should, therefore, be allowed to appropriate them. That they may be turned to useful account in the way suggested there can be little doubt, for whatever may be the opinion regarding the practicability of attempting to supply the entire Metropolis with water by means of boring, there can be no question as to the sufficiency of supply for the Parks only, and surely it would be advisable to obtain this supply of the purest water, when the depth at which the spring is to be found could be ascertained at very small expense. The experiment should be made in the centre of the lake opposite the palace, and the water entering as a fountain, would thence be conducted to the head of the Serpentine, where the fountain suggested in my former plan should be, though of a form somewhat more picturesque than that at present existing, and finally flow off at the lower end, to supply the other ornamental waters in the Parks. To render the bathing place on the banks of the Serpentine, as complete and useful as possible, it would be convenient to have on each side of the river, for about 200 feet in length, a single row of forms, with backs and small partitions under the seat, for the bather to deposit his clothes; this arrangement would neither be unsightly, nor intercept the view; but would, on the contrary, furnish comfortable sheltered, and agreeable seats during the day for loungers.

Having thus explained how an abundant quantity of water may be procured without injuring the navigation, or the picturesque beauty of the river or its tributaries, it is

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neces sary to show how the waters above the weir and point of supply, may be preserved from pollution; which I can best do by referring to the first division of this plan, describing the removal and distribution of the sewage for agricultural purposes; merely adding in this place some details which recent circumstances have suggested to me as advisable for its more advantageous practical working; and for its special application to the banks of the higher part of the river. Following out the mode of working by distinct portions formerly recommended, it only remains now to suggest the most desirable sewage stations above the weir, and for the western division of the Westminster district of Sewers.

The deviations of the Metropolitan Sewage Manure Company from their original plan, and from the provisions under which their first act was granted; having raised an apparently insurmountable barrier to farther effective proceedings, their present engine power being totally inadequate to the distribution of a large body of sewage, I am induced to recommend for consideration the following mode of dividing the sewage portion of the extreme western district of London, as possessing many advantages in point of economical arrangement over those which have hitherto been advanced. Instead of conveying the King's Scholars Pond, Ranelagh, Millman's Row, and intervening Sewers to an engine station near the mouth of the Kensington Canal, the sewage between and belonging to these sewers should concentre and unite at the weir, and thence be carried across the river by means of a main pipe laid in the bridge (see plan B) and road, until it meets the Southampton Railway, in the embankment of which it could be conveyed towards the Surrey Hills or Bagshot, with services and taps at convenient points for distributing the sewer water over the soil, and to the covered tanks, there being many elevations

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upon the line, suitable for such manure reserves. By this route, the breaking up of many streets would be avoided, and the sewage would reach the country by a shorter and less populous line than any other in the same direction, whilst the Railways in the vicinity afford the required facilities for conveying the produce of the land to the Metropolis.

That part of Fulham which comprises the Common Fields, Parsons Green, Walham Green, North End, &c. being at present inadequately drained, might have a small sewer or drain pipe laid in the public roads, for the supply of the surrounding market gardens, and as the sewage must not be discharged into the river, and the ground is a dead level, this drain should be inclined towards the Stanley Bridge Station, or to the head of the Kensington Canal, an excellent central point for the engine to take up the sewage of this district and Kensington, and of the rapidly extending suburbs Notting Hill, Norlands, Shepherd's Bush, East and West Acton, and Hammersmith, all at present discharging into the Counters Creek sewer, which under the name of the Kensington Canal poisons the atmosphere of the West of London. By adopting the weir the canal would always be full of pure water, presenting the advantage of affording the supply for diluting the sewage.

The Grand Junction Engine will take up the sewage of Brentford, and the surrounding population, and force it on to the most suitable distant localities, as the manure is valuable in proportion to the distance from the source of supply, being of no value near the town. The engines for pumping the sewage must always be kept as near to the river as possible, to afford facility for sending water into the country in the dry season, when it would be as essential as the manure itself. In all those populous parts situated above the water supply, it might be desirable to adopt the suggestion

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contained in the plan submitted in 1843 to the Health of Towns Commissioners, for separating the house from the surface drainage, and highly approved by some practical men; it was to make the foundations of all buildings as elevated as possible, and for each house to have two drains, one for the surface or flood drainage, flowing into and sweeping the main sewer; the other small, and discharging into a drain leading direct to a closely covered district receptacle, which should be of sufficient capacity to receive from 12 to 24 hours house drainage, in reserve, at such period when the pumps will be required to convey water only to the land. This will not involve any great size for the receptacles, as the quantity of house drainage when relieved of the surface drainage, is very small, and always uniform. The surface, or flood drainage, on the other hand, being only occasional, the large sewers or conduits of the present system of drainage, are necessary to carry it off: it must, therefore, be evident that by separating the two, nothing but pure water would enter the river, whilst all the fertilizing material would be saved, and the means secured for diluting it to any desired extent. In new districts the system could be easily effected, but even in many old localities it might be adopted without difficulty, by making the house drain on the top, or a little on one side of the great drain, keeping near to the surface, to avoid intercepting each other, or expense in construction. The plan of pipes and district receptacles could be adopted wherever the main sewer is too small at the lower end, to admit of any augmentation of sewage: it is also peculiarly applicable to poor, crowded, and as yet undrained neighbourhoods, like Spitalfields and Bethnal Green, and to those suburbs so distant from the river or main intercepting sewer, as to require a great length of drain, as the pipes and receptacle would cost less, whilst the lower drains being so relieved of an immense body of

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drainage might be made much smaller, and no smell could possibly arise from the gullies, as only rain water would flow down the sewers.

The house drainage of all isolated buildings or cottages, however humble, should in like manner be conveyed by small pipes into covered cesspools, there being either one for each house, or where the houses are sufficiently near, a cesspool common to all; where the villages are wide and straggling, an earthenware pipe should be carried through to its whole length, the expense of the pipe and small receptacle being defrayed by the landholder, who would receive an ample return by employing the manure upon his land; where the manure is not sufficient in quantity to warrant using engine power, covered watering carts might be used; but in all cases where there is a sufficiency of fluid, engine power is found to be the cheapest and readiest mode of distributing it over the soil.

After these few additional recommendations as to the diversion of the sewage above the weir, and the application of the principle of separating the drainage under certain circumstances; it only remains for me to explain the local improvements on the banks of the river before introducing that division of the plan which relates to "Inland Drainage."

In order to secure the health of the population within the city, the state of the surrounding neighbourhoods should be carefully attended to—no bogs or marshy grounds, osier beds, stagnant waters, sluggish streams, canals, ditches, or open sewers; foul nuisances, or smoking factory chimnies being permitted to exist there any more than in the town, for whichever way the wind blows it carries along with it the poisonous miasmata generated in the suburbs. Now the south-west wind is a prevailing wind in London, but this wind can never blow without impregnating the air of the best and most fashionable

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quarter, with all the impurities of the damp, imperfect and ill-managed banks of the river from the Houses of Parliament to Brentford,—all the foul air from the mouths of the sewers,—and all the foul smoke from the gas works, lead works, potteries, and other factory chimnies that should be compelled to consume their smoke. The river ought to be the most healthy part of the Metropolis, as running water is by nature a purifier, carrying along with it a constant current of air, whereas wet and marshy soils have more evaporating surface exposed, the exhalations being also of the worst and most dangerous description. At present the ground on the banks of the river is in places so low as to be under water several times at each new and full moon, most prejudicially affecting the air of the surrounding neighbourhood; the Fulham Town Meadows just above Battersea Bridge for instance are so situated, and no remedy even attempted, though the spot is capable of being rendered both healthy and lovely at small cost, there being no obstacles in the way. The soil might be drained by digging a graceful channel for a piece of water, the material excavated being employed to raise the ground above the water level, the front next the river being faced with slate planking, which can be procured of the proper form, dimensions, and thickness, at the rate of 6d. a square foot: the water in the excavated channel should enter at one end, and flow off at the other, like an arm of the main stream, and the form being properly varied and planted on the sloping banks, it would constitute a beautiful and picturesque addition to the landscape. Again, around the Bishop's Palace at Fulham, is a stagnant moat and great foul ditch, with swampy ground next the river; this should be treated in the same way, both for the benefit of the inhabitants of the Palace and of the public, as the spot is at present highly dangerous, when it might be rendered

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most beautiful and healthful at small expense. The public walk should here and there diverge from the banks of the river to vary the scene, for utility should not be the sole object considered;—the eye and imagination should likewise be gratified, if for no other purpose than to induce the innocent and healthful recreation in the open air, of walking, fishing, or boating. Wherever the banks of the river are so low as to be liable to be overflowed, whether by tide or flood, they should be slate planked, or built up so that the waters shall never rise beyond their proper limits, and thus the navigation will be permanently maintained, whilst the waters being preserved from pollution, will always be sufficiently pure for domestic purposes.

The next division of the subject that naturally presents itself is Inland Drainage, without which, indeed, no matter what precautions may be taken, in other respects, no system even of town drainage can be complete, as the two must necessarily work together.

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Tabular View of the Expenditure, and of the quantity of Water supplied by the Water Companies of London,

According to the returns made to Parliament in 1834.

Name of Company.	Gross expenditure to 1833.	Annual current expenses.	Expended on Engines and Engine Houses.	Expended on Reservoirs & Land.	Expended on Pipes.	Height of Supply above the Thames.		Average daily supply for Houses, Buildings, and Street waterings.		Number of Engines.
						Mean height.	Highest	Gallons each House.	Aggregate quantity.	
East London.	£. s. d. £594,988 — 9 for engines, reservoirs and pipes.	£. s. d 15,889 — —	No special return.	No special return but 19 acres of depositing reservoir.	No special return, but 200 miles of iron pipe in 1828, some 7 Gs. a yard.	Feet. 60	Feet. 107	120	5,593,896	Two of 80 H. P. each One of 70 „ Two of 30 „ and 76 H. water power
New River.	1,116,964 — —	38,000 — — likely to be increased.	No special return.	No special return. 5 acres at Clerkenwell 1 do. at Pentonville 38 do. on 50 acres of land at Newington.	No special return.	84½	145	241	16,904,945	Two of 60 H. P. each One of 100 „
West Middlesex	404,963 2 6 for engines, reservoirs and pipes.	18,000 — — exclusive of reserve fund.	Expended on these kinds of Works between 1828 & 1834 £78,239. No special return.	No special return.	3½ miles of mains to Kensington. 7 to Barrow Hill.	155 that at Kensington. 122	188 Barrow Hill.	185	3,060,000	Two of 70 H. P. each One of 105 „
Grand Junction	331,174 1 7	11,000 — —	£46,531 14 9	£80,728 7 8	£175,008 11 1	100	151¼	150	1,200,576	Two of 100 H. P. each One of 70 „
Chelsea.	271,311 3 9 exclusive of labour and repairs.	17,981 — — exclusive of reserve fund.	No special return. Expense of pumping to filter bed £800 a year.	No special return.	No special return.	85	135	168	2,337,000	One of 70 H. P. One of 60 „ One of 25 „
South London.	245,306 13 10	5,000 — —	No special return.	No special return.	No special return.		80	100	1,200,000	One of 45 H. P. One of 20 „
Lambeth.	182,553 — —	6,500 — — exclusive of reserve fund & filtration.	No special return.	No special return.	No special return.	55	135	124	2,075,000	One of 110 H. P. One of 80 „ One of 36 „
Southwark.	Since 1823 £25,000 have been expended on works.	No return.	No special return.	No special return.	No special return.	38	60	156	1,107,600	One of 42 H. P. One of 20 „

The Statement of Annual Expenses contains no provision for repairs, improvements, casualties, &c. which would amount to a large sum.

The supply is supposed to be nearly doubled since 1834, so that the annual expense of purifying has proportionately increased.

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TABLE shewing the quantity of Water in the River Thames flowing over Teddington Weir, together with that which flows into the river from the Colne at Isleworth, about 4¼ miles below Teddington Lock, and the distance below the Weir which would be filled up by such river water if emptied five times in every twenty-four hours.

See House of Commons Report on Water Supply, 1834.

Quantity of water in cubic feet flowing over Teddington Weir, with that flowing into the Thames at Isleworth from the Colne per minute.	Quantity of water in cubic feet flowing over Teddington Weir, and also from the River Colne at Isleworth, in 24 hours.	Distance below Teddington Lock that the above River Waters would fill up to low water mark five times in every 24 hours, and to high water mark 2½ times.
Cubic feet 56,412	Cubic feet 81,233,280	Five miles below Teddington Lock, viz. at the ninth mile post above Battersea Bridge, and above the confluence of the Brent.

On Tuesday, the 15th July, (the Tides being at neap,) the tide only flowed one hour at Richmond, the ebb lasting 11 hours; the summer is of course the period when the flood ascends the greatest distance, from there being less water from the sources of the stream; there are several months in the year during which the tide at Richmond never turns

By order of the Court of Directors of the Grand Junction Water Works Company.

Brook Street, Grosvenor Square,
16th July, 1834.

W. M. COE, Secretary.

Mr. W. Anderson states that the above is the average of three sections taken; but if taken at the height of one foot six inches, flowing over the paddles at Teddington weir, which he understood from the men at the lock would be the flow, the water at that time would make 58,149 feet, and according to the regular summer height, it is full two feet over the paddles, it would be 75,600 cubic feet a minute. Mr. A. farther says, that the calculation of the distance that the waters would fill up, is at a mean width of 200 feet, and depth of 3 feet 6 inches, the ordinary tide rising about 6 feet at Kew, and about 1 foot at Teddington lock, the mean of which is 3 feet 6 inches.

The quantity of water flowing in the Wandle is stated by Mr. Telford in the same report to be 1,020 cubic feet a minute, or 1,468,800 cubic feet in 24 hours.

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THIRD DIVISION.

INLAND DRAINAGE.

The unwholesome fogs that prevail around London, principally originate in the lamentably defective drainage of the neighbouring lands—in the numerous stagnant pools, open ditches, and undrained marshes in the east; and cold clay lands along the banks of the Thames, Colne, Lea, Wandle, &c. &c. When these spots are thoroughly drained, the fogs will cease, and London become the most healthy city in the world; it behoves all, therefore, to consider the best means of obtaining such truly important results.

It appears to me, that hitherto, sufficient distinction has not been drawn between land drainage and town drainage, the principles of which are diametrically opposed—the operation of the first being to leave every impurity behind in the soil, the drain itself running only pure water; whereas, in the last, all moderately fluid refuse should be discharged into the drain, which would continue to increase in impurity as it progresses; thus, land drainage in reality terminates where town drainage begins, the perfection of the one being, that it must be entirely free from pollution, whilst the other cannot be too gross and impure at the outlet.

The land drainage, however, can never be complete or

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unmixed with earthy matters under the present system of slight and imperfect open ditches, for the following reasons—first, as soon as made they either fall in, or are grown up with weeds, becoming bogs from these and various other stoppages: secondly, through the stoppages, the water which should go to the tank for the cattle, or be reserved for irrigation, is entirely wasted: thirdly, this water becomes stagnant, and even when clear of house drainage, so poisonous in itself, as to infect the surrounding country, not only injuring the health of those who live near it, and of the cattle, but causing rank and mischievous vegetation: and fourthly, is the consideration of the great waste of ground under these united circumstances. To remedy these evils, and secure the pure run of rivulets, the banks should be lined with pebbles or slates, wherever so soft and earthy as to be likely to wash up; the clay and loose earth should be cleared away from all bogs, until the spring which causes them is reached, when a well properly lined with stone or slate should be made in proportion to the size of the spring: the surface should then be cleared, and a properly inclined course for the water made to run to the rivulet or reservoir, with as many slate troughs on the line as might be required and the waters being thus enabled to flow uninjured and unimpeded to the main stream, would always be fit for every purpose whether domestic or otherwise. As the open trenches in and at the sides of the fields are recommended to be superseded by under drains, the following is the mode of filter drainage which I propose to adopt. Deep parallel trenches or drains filled with sand, and having perforated drain tubes laid in the bottom, should be formed at considerable distances apart; and transversely, of these small and less deep sand drains should be made to facilitate the passage of the water to the tube

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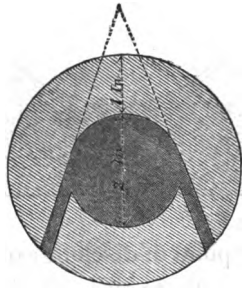
drains, by which the water would be conducted away to the unperforated pipes, which will finally discharge it in a perfectly pure state into the stream, irrigation reservoirs, and cattle troughs.

The following diagrams show the forms of my patent pipe.

In No. 1, the pipe has simply a line of holes on each side, the perforations inclining to and converging at a point above the top of the tube, this point to be regulated by, and equal to the thickness of the tubing: by this arrangement, although the tubes be surrounded with fine sand, yet the water will filter downwards, and rise up through the perforations, without carrying any of the sand into the pipes.

No. 1.



In No. 2, the lines of holes are in the upper part of the pipe, and slant downwards, the semicircular cap which covers them allowing the water to filter upwards and enter the holes, producing the same result as No. 1, though the construction presents some superior advantages.

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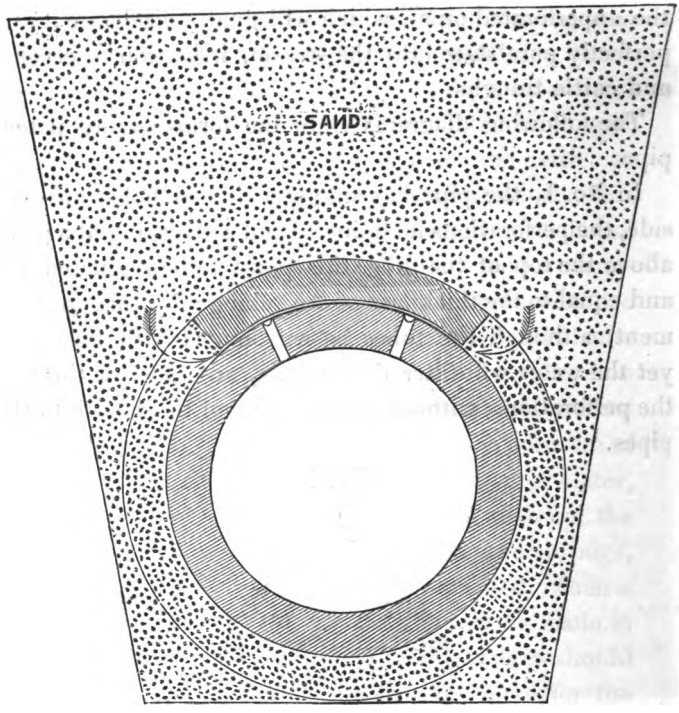
No. 2.



The extremity, or point of discharge of every pipe, should be protected by my patent valve, which will remain closed when at rest, though a slight pressure from within will press it open, whilst any pressure coming in the opposite direction, will keep it closed.

As an economical means of cutting the drains is a very important consideration, not only in this but in every system of drainage, some mechanical apparatus will be necessary for the purpose; I have therefore patented a machine for cutting drains in clay, or other soft, wet land, and depositing sand in the drain, as shown in the following diagram, No. 3.

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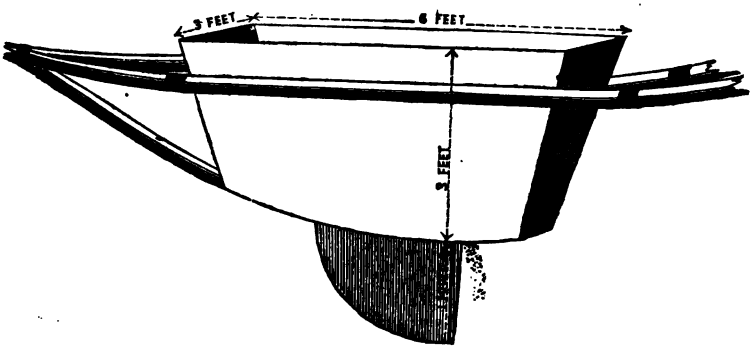
No. 3.



It consists of an upper compartment for containing dry sand, there being a cutter fixed at the under part, immediately behind which is an opening, so that the sand may flow down, and be deposited in the cutting made as the machine advances. This machine is to be drawn along the surface of the land as a sledge, the weight pressing the cutter into the soil, and forming the trenches above described. Every ditch and country road side should have a small pipe like No. 2, laid down to carry off the water; and there should likewise be a tank in each field, so large as to contain a sufficiency of water for the use of the cattle in the dry season.

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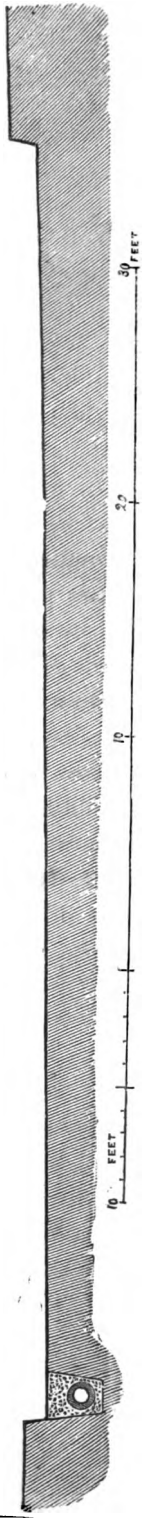
No. 4.



No. 4 shows the section of a road inclined towards the pipe drain, as in country roads one such drain would be sufficient.

Although in the preceding pages, I have dwelt upon the propriety and necessity of conveying water as well as manure to the land, yet I would on no account rob the Thames for distant districts; on the contrary, natural streams should always belong to the country through which they run, excepting where there may be a superabundance, when the surplus might be taken for the more arid spots, and no water being allowed to run to waste, there would be sufficient for every purpose. To attain this at that season of the year when water is much required to mix with the manure, and to distribute over the sandy lands; all the waste flood waters of the rainy season should be dammed back in such places as might most conveniently facilitate agricultural operations: thus the river Brent, which owes its waters solely to land floods, and in flood time is of no inconsiderable size, might be permanently maintained as a reservoir for these objects; and again, near Chertsey and Weybridge, the river Wey, which is very turbid in time of flood, might be similarly reserved for irrigating the sandy lands in the neighbourhood. There are other streams in the same vicinity, such as Bourne Brook, admirably adapted to the purpose; and the numerous ponds and backed waters already existing on many heaths, are evidence how desirable and useful a more general and uniform system would be.

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All marshy or boggy lands should be excavated so as to obtain a lower level and increased fall, and the reservoirs thus formed having proper embankments and outlets. would not be stagnant, as the fresh supplies constantly entering, would as constantly be discharged in irrigation and in diluting the manure. The Virginia Water in Windsor Forest is nothing but backed water; and though the water itself is not clear, yet by adopting the foregoing suggestions of lining the sides with slate, and rectifying the present marshy banks by the filter drainage, a more lovely spot would scarcely be found, affording a happy example that such backed waters would add greatly to the beauty of the country landscape. This, however, is not all, for the improved drainage would render the land more productive and the air more healthy; whilst the power and capabilities of the natural streams being preserved, and all the drainage and sewer water, which at present pollute them, diverted and rendered available for the readiest and most beneficial application to the soil, the whole would form a uniform system, so intimately connected together, that no individual part could be separated without detriment to the remainder.

When I first published the outlines of the foregoing plans more than 20 years ago, my impression was, that works of the above nature were far too extensive and important to be intrusted to private speculation; but that as the government has charge of all relating to the physical and moral condition of the people, to which ends nothing can be more essential than cleanliness and good air, the government alone should direct the supplies of water, and systems of drainage, and of ventilation, and not leave these vital subjects to the caprices of corporations or of individuals. Although general opinion at the time was against public interference, my early impression has since been

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fully confirmed by actual experience; for in consequence of the government in 1836 declining any participation in such works, I exerted myself to accomplish my objects by other means, and eventually succeeded in establishing a Company for carrying out one portion of my project—the "Diversion of the Sewage from the River, and its application to agricultural purposes." Thus I would appear to have attained a desired point of success, but on the contrary, every object has been retarded by an unavoidable defect in the constitution of all companies—namely, that individuals gradually enter the direction, who, however favorable to the ends in view, are quite unacquainted with the details of the operations. Unfortunately the Metropolitan Sewage Manure Company is in this position, for the directors are totally ignorant of the means of effecting the great national work they have undertaken to conduct, and instead of being guided by the plan they profess to carry out, and of profiting by the knowledge and experience of myself and other original promoters, who, like Mr. Hawksley, are practically conversant with the subject, evince their incapacity by petty experiments with inefficient machinery to prove facts that have been long established by others. From the first I have protested both at the board and publicly against their measures, and urged the necessity of preserving the integrity of the promises made to the public. I was overruled by the majority, though my representations have all since been confirmed. An engine station has been erected remote from the sewer water the directors engaged to supply—the Commissioners of Sewers have repudiated their deep Tunnel Sewer, but accord them permission to distribute the *water of the Kensington Canal,* which, however impure, is very deficient in those fertilizing agents which abound in the large town sewers: whilst the appropriation

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of the Ranelagh and King Scholars Pond Sewers, is indefinitely postponed, as the present engine power is entirely inadequate to the distribution of these large sewers, being indeed no more than equal to distributing the sewer water of the immediate neighbourhood round the station. Thus not only will the purification of the air and water originally promised be fallacies, but the very first experiment upon the land near London, though ostensibly a trial, can afford no just results or data for future operations—the experiment to be fairly tried must be with sewer water, and the power of the engines sufficient to force it to that distance from the town where it will be of most value, and for distributing it by hose, for which altitudinal pressure is essential, the saving of engine power being the very worst economy, as under all circumstances the working of the fluid through pipes and hose is far cheaper than any other mode that can be adopted. The delays occasioned by the vexatious proceedings of the company have been in all respects most disheartening to me, and but for the intense vitality in the object, would have fatally prevented further efforts in the cause: public attention, however, is now so alive to the necessity for improving the sanitary condition of the country, and for providing remunerative employment for the people, that I am encouraged again to hope for governmental support to my proposals, which at once afford permanent employment for the agricultural and labouring classes, augment the produce of the land, and improve the health and comfort of all. The first steps gained, namely, the embankment of rivers, improvement of the drainage of towns, and useful employment of the refuse—we may then expect more important results—that the waste lands in the hands of government may be connected with the town drainage, and placed under a comprehensive management, with a

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view to instructing agriculturalists by improvements in cultivation commensurate with the science of our age; thus combining a source of useful education with the means of employing the people upon works which would eventually amply repay the outlay, add to the revenue of the country, and decrease the taxation for the support of the poor.

DESCRIPTION OF MODE OF IMPROVING THAMES STREET,

AND OF INTERCEPTING THE SEWAGE BELOW BLACKFRIARS BRIDGE.

The enormous value of the property near the river between Blackfriars Bridge and the Tower, have, hitherto, rendered futile every attempt at obtaining a good line of thoroughfare, or means of diverting the sewage. It appears to me, however, that both these advantages may be secured without interrupting the traffic or removing the present warehouses, by forming a double way in Thames Street, one line above the other—the present low roadway to remain, and the upper way, which should be on the same level as the ends of the bridges, serving for the main street, the working of the cranes, and the necessary business of the warehouses being facilitated, and great saving of horse labour effected. The accompanying engraving illustrates the proposed alteration, showing the covered wharves, with public walk above—the warehouses—the double roadway and the shops.

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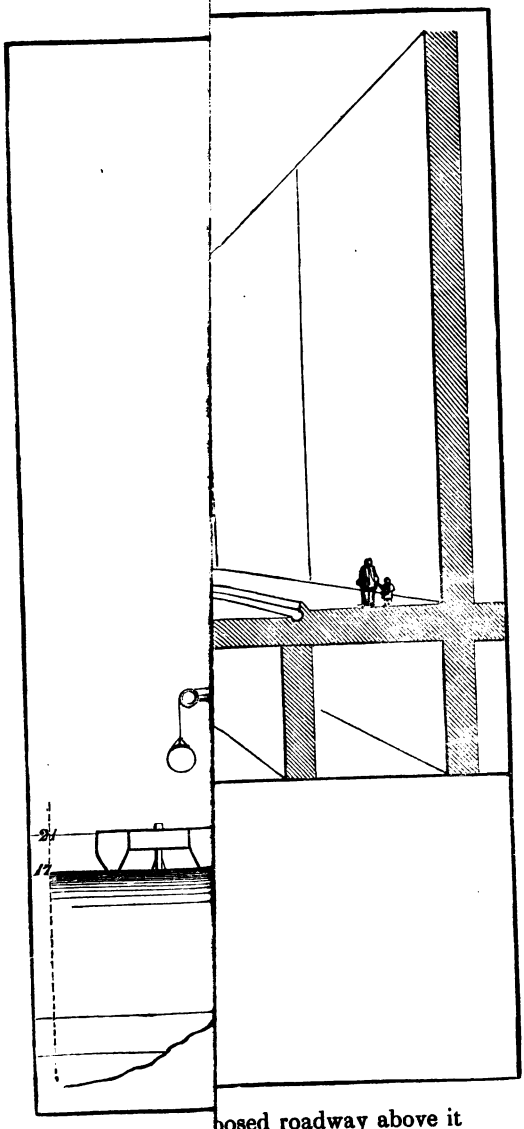

posed roadway above it
on without encroaching

Transverse S
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N MARTIN, 1845.

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To accomplish these objects with security and economy, my fire proof beam of wood and iron should be employed in the following way: the level of the upper roadway being determined by the height of the ends of the bridges, the beams to support it should be laid across from one side of the street to the other, being let into and resting upon the walls of the houses, or upon cast-iron pillars where the strength of the existing foundations may be insufficient: these beams should be about 12 feet apart, and strong framed wooden planks, about 4 inches thick, and cased in sheet iron or zinc, should be fixed from beam to beam, and the whole road-way finally covered with asphalt. By having all the beams and planks prepared ready for fixing, no time would be lost, and the whole work would be effected without obstructing the general traffic below, whilst the lines of roadway being secured, the street might be widened, at any future period that such an additional improvement might be deemed attainable, and the combined economy of space and construction would render the undertaking highly profitable. One very important consequence of thus raising the traffic, is the opportunity it would afford for making the intercepting sewer, which should commence at the first sewer above Southwark Bridge, running along Thames Street, intercepting the sewage in its course towards the Tower, where the engine for pumping it off to a reserve depôt at the river Lea should be: the intercepting sewer need not be larger than the first sewer it takes up, and by directing the drainage for half a mile east of the Tower, down to the engine of the Thames Street district, one station would serve for a large section of the city, from whence the difficulty of removing the sewage has always seemed nearly insurmountable. The sewage of the most eastern district should be carried down Ratcliffe Highway to the Limehouse Canal, where the engine should

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be, care being taken to preserve thorough ventilation, by allowing no air to feed the fire of the engine, but that which proceeds from the sewers. The silt well of the engine must immediately adjoin the perforated plate where the sewage enters the pump well, and as the dredging wheel would be in almost constant use, in separating those grosser parts that would not freely enter the hose, this plate must be sufficiently large to admit a plentiful supply of fluid to feed the engine, for unless the mouth of the suction pipe is completely immersed in the pump well whilst the engine is at work, air will enter the pipes and occasion great loss of power and obstruction.

PLAN FOR ALTERING AND REMODELLING WESTMINSTER BRIDGE;

The principle of construction being equally advisable for the New Bridge at Chelsea; and applicable to Battersea, Putney, and all Bridges across Rivers with low banks.

The difficulties to be met in erecting or altering a bridge at Westminster are—the lowness of the banks and of the surrounding approaches—the height required for the centre of the bridge in order to afford free passage for the craft,—and the necessity for maintaining the water way clear and unobstructed. To meet these difficulties, there appear to me but two means:—The first a Suspension bridge, which would afford not only a clear navigable way, but the greatest head way, should have the preference, but for

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its defective appearance in composition at this particular spot, and the vibration inseparable from these structures, which renders them unsuitable where there is much heavy traffic. The next, and that which I think the better plan is, to remove the whole of the present superstructure, and every alternate arch and pier down to the level of the bed of the river, and to construct upon the piers left standing, a roadway formed of the fire-proof laminated beam, as beams on this construction combine the wood and iron in the position of the greatest strength and the smallest compass, affording ability to lower the roadway more than by any other method. The beams which could be made of any length by lapping over, and fixing a flat piece of iron at the junctions, with bolts to screw the whole together, should be placed from pier to pier, about five feet apart, with stay beams producing the principle of the arch;—the pressure, however, being perpendicular, and not lateral as in the common arch, this would stand alone without the support of the other arches and piers. To form the curb and parapet, a single plank of cast iron should pass right through the roadway, that for the curb being two feet above the level of the pavement, separating the foot from the carriage way without loss of room,—securing the footway from accidents, and increasing the strength of the bridge itself. To complete the roadway, cast iron planking, one inch and a half thick, should be laid transversely from beam to beam—upon this deal planking three inches thick, laid longitudinally,—and lastly, the pavement of wood and iron, coated with asphalte, mixed with whinstone or scoria from the furnace, (as a preventive to the slipping of the horses) or with a preparation of caoutchouc, the whole constituting a permanent covering to the roadway of the bridge. The entire thickness of the solid part of the superstructure of a bridge upon this principle

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would be only three feet, or one foot more than that of the suspension bridge, instead of seven or eight feet, the lowest allowable in one of stone; it, likewise, possesses all the advantages of span of arch, narrowness of piers, and extended line of headway, without any of the disadvantages of the suspension bridge, and with the addition of superiority in taste, style and fitness, united with strength and durability. I propose to lower the roadway of the centre of the bridge nine feet and a half, and to raise the ends to the level of the streets, giving an incline of one in fifty, a slope no more than requisite for good drainage, instead of the present inclination of one in fourteen. By lowering the roadway so considerably, there will undeniably be a diminution in the height of the arch, but I think this will be quite counterbalanced by the width of the head-way, the arches being, nearly all, of equal height: if, however, this farther depression of the arch will still be inconsistent with actual convenience, the maintenance of the superior elevation will only cause an immaterial additional inclination in the roadway, without affecting the principle of the bridge: I am also enabled, without interfering with the existing works at the piers of the bridge, to increase the width of the roadway to sixty feet, ten feet for each footway, and forty feet for the carriage road, whilst the water and navigable way below, will obviously be nearly trebled by the alteration of the arches. As regards the external appearance of the bridge, the whole of the castings should be simple to resemble stone, with little or no decoration excepting for the cornice, and whatever ornament is introduced should be in the gothic style of art. It will, at once be seen, by examining the drawings and plans in my possession, that the strength of the bridge depends upon the principle and lightness of the beam; and that the piers, though reduced

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to one half of their present number, will be more than sufficient to support the entire superstructure without increasing the strength of the foundations, thus avoiding the heaviest portion of the expense of a new bridge,—the construction of new and secure foundations. It is equally apparent that the amount of stone recovered, by removing the alternate piers and superstructure, would repay a large portion of the expense of the new erection; and I, therefore, hope that these indisputable and important advantages may lead to a favorable consideration of my proposition. As, however, the alteration I propose is so great, as the substitution of a bridge of the lightest construction and appearance, for one in all respects the reverse, it may be necessary to offer a few observations in support of a plan founded upon my conviction, that bridges should always be light in their structure. I cannot do better than avail myself of the remarks of Professor Hosking upon the subject of Bridge building generally, (Institute British Architects, May 15th.) He had on a previous occasion "urged that the piers of bridges were built of much greater substance in thickness than was necessary for either safety or general effect; that they might be greatly reduced in bulk, both for economy and for their effect upon the water way, and without diminishing their efficiency. It had been objected to him, however, at that time by some of the members—with the too common fault of architects, who would sacrifice use to effect, instead of compelling the useful to be effective—that this proposal tended to destroy the due proportion in appearance of the pier to the opening. The eye that had been accustomed to the bridges upon the Tiber at Rome, of which the piers are rarely less than one third the span of the larger of the two arches resting upon them respectively, would be offended by the absence of that proportion

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of solid to void in London and Waterloo Bridges, in which the same relation is but one sixth; whilst the eye accustomed to the bridges upon the Thames at London would condemn the Bridges at Staines, and the bridges of Jena and Neuilly on the Seine, of which the piers are but one eighth, one ninth, and one tenth of the span of the arches resting upon them. Nor have we yet reached the limit to which the diminution of proportion may be reduced with safety and good effect." It needs but farther to observe, that the most beautiful and the noblest structures over the Thames at London, namely London and Waterloo Bridges are likewise the lightest, and that though this bridge of mine is even still lighter, the piers and arches bearing the same relative proportions as the bridge at Neuilly, yet as it equals them *in strength of construction*, any proportionate appearance of solidity may be given, that may be desired by those who hold that a bridge should not only *be* strong, but *look* so. I submit, however, that we do not design for the eye of ignorance,—that mere weight is no proof of strength, but often of the contrary, as in this very bridge at Westminster, where its weight is its great weakness,—and it is this weakness from overload that I propose to remove. To still farther improve the foundations of this and all the other bridges by equalizing the current, and rendering the river deeper and more navigable, I recommend placing sub-weirs about one foot above the present mean bed of the river, at regular distances from each other. As there is a fall between Westminster and London Bridges of about five feet, which these weirs would regulate and equalize. A sub-weir should be placed a few yards below Waterloo Bridge, nine inches above the mean bed, and for two hundred feet of the width of the river, and sloping from thence to each of the shores to the height of mean low water mark. At Blackfriars Bridge the weir should

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be one foot, at Southwark fifteen inches, and at London Bridge two feet above the bed of the river—thus the foundations of the bridges would be preserved from the injury they at present sustain by the scour round the piers; and the whole bed of the river would always be covered at low water. A river wears its bed if it has a fall of only five inches in the mile, whereas the Thames at this point has a fall of more than five *feet!* This rapid fall particularly affects the lower side of London Bridge, where there is a hole thirty feet deep at low water, into which the foundation is being continually and rapidly swept, and if not protected, this noble structure will ultimately sink yet deeper on the the lower side, until the whole will follow, and that at no distant period, the weight of the superstructure pressing more heavily as the foundations are removed, and the heaviest body of water is besides on the upper side of the bridge.

Whilst on the subject of improving the river, I venture to add a few words relative to the present unsightly and inconvenient floating piers. No one can now dispute the advantages which floating piers possess over the old solid pier, but there can be no reason why their appearance should not equal their utility, I would therefore propose to substitute for the present cumbrous barges, simple platforms, attached to the shore by a chain or hinge, leaving no ugly space between the landing platform and the firm bank; this platform would rise and fall with the tide, and as a yet farther improvement, the outer line should be protected by an elastic band or cushion to break the sudden contact of the craft.

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TABULAR VIEW OF THE BRIDGES AT LONDON, ACCORDING TO MR. BRITTON, 1828.

	Length to opposite banks.	Width.	Height from low-water to top of parapet.	Height from low-water to surface of roadway.	Height of centre arch from low water.	Span of centre arch.	Number of arches.	Span of solids, or piers in the width.	Water way.	Materials.
LONDON	920	56	55	50	43	150	5	92	690	Granite, &c.
SOUTHWARK	700	42	53	52	43	240	3	48	660	Iron.
BLACKFRIARS	1000	42	62	54	44	100	9	207	793	Portland Stone.
WATERLOO	1326	42	54	50	42	120	9	160	1080	Cornish Granite.
WESTMINSTER	1066	42	58	50	39	76	15	246	820	Portland Stone.
Westminster as proposed to be altered by Mr. Martin.	1066	60	44 or 46	40 or 42	37 or 39	165	7	123	943	Iron, Wood, and Stone.

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THE LONDON CONNECTING RAILWAY.

As it is acknowledged that the various railways leading to the Metropolis require to be connected with one another, and to communicate freely and easily with the port and different districts of London, on both banks of the river, I will endeavour to describe the line I have laid down, and a reference to the map will show that while the Railway is connected with the very heart of the city itself,—will touch every railway both existing and projected,—and border closely upon all the populous quarters,—yet that these advantages will be effected without encroaching upon private property, injuring vested interests, or interrupting present lines of traffic and communication within the Metropolis.

The following enumeration of the principal places will suffice. The Railway should commence at the River, close to the East India Docks, cross over the River Lea, and Limehouse Cut at Bromley, Mile End Road, near Stratford-le-Bow, form a junction with the Eastern Counties and Northern and Eastern Railways, and join the Blackwall Railway by a Branch down to Limehouse and the River; it should proceed past Victoria Park and Bethnal Green, Hackney, Shoreditch, and Hoxton, connecting in its course the Kingsland, Islington, Holloway and Liverpool Roads; past White Conduit Fields, Kentish Town, Hampstead Road, Camden Town, forming a junction with the Birmingham Railway; by the back of the Regent's Park, beyond Primrose Hill, the Canal, and Portland Town, to the Edgeware Road, Kilburn, across the Harrow Road and Canal near Kensal Green, joining the Great Western Railway at Kensal New Town, passing

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behind the Norland Estate, and intersecting the Thames Junction Railway; crossing the Oxford Road near Shepherd's Bush, passing Brook Green and Hammersmith, continuing to North End and Fulham Common Fields, to Walham Green, the Fulham Road, Parson's Green, King's Road, to the Town Meadows, opposite Battersea; across the Thames by a Bridge serving for both Road and Railway, passing Battersea through the Fields, forming a junction with the South Western Railway near Piddoes Farm, intersecting the Kingston Road, to Nine Elms; then the Kennington Road and Vauxhall to the Great Central Depôt at the Obelisk, where all the present roads from the bridges concentre; thence to the Great Dover Road, to the Croydon, Brighton, and South Eastern Railways, and then uniting the Greenwich Railway at Bermondsey to the Coal Depôts, Dock Yards, and Trade at Deptford: thus completing the continuous line of Railway round the whole of London; communicating with the river at five distinct points, and with additional stations near each leading suburban thoroughfare; every station being, in point of fact, a Terminus, from, or at which, a journey could begin or end.

It is now superfluous for me to do more than respectfully urge the consideration of the above described Continuous and Connecting Railway, which affords all the advantages of perfect internal communication, from the facilities of approach to every station, all parts of the Court end of the town being from a mile to a mile and a half, and the business portion of the town less than half a mile, of one or the other; thus relieving the centre of the already too great press of traffic, by throwing it towards the extremities, and at the same time greatly increasing the convenience of the suburban districts; besides the vast importance of the central depôt at the Obelisk;

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and the freedom from the disadvantages of broken lines of communication—of clearing away valuable buildings to form a railway terminus in the heart of the city—and the right which every railway would justly claim to advance its terminus to the seat of business—all which objections are met by such a connecting line as I have laid down.

In conclusion, I will merely urge the necessity of proceeding upon some uniform plan, and add the following extracts from the Report of the Railway Termini Commissioners, strongly recommending such a line as I have here described :—

" It is our opinion, supported by the evidence of experienced and very intelligent witnesses, that so far as an easy, unbroken, and economical communication between the northern railways and the docks, or the east of London generally, is concerned, this object can be more conveniently and surely attained by a line which should pass outside the metropolis on the north, at such a distance as to avoid interference with populous districts and thronged thoroughfares, and so connect the goods stations of the various railways from west to east with each other, terminating at some convenient point on the Thames or within the docks. Such a railway, it is true, would not bring the merchandise of the north and west so near to the warehouses in the city, as the prolongation of some of the northern lines to Faringdon Street, Aldersgate Street, Fore Street, &c.; but without anticipating the objections which we shall shortly have to make to these projects, it is sufficient to observe that the execution of any, or even of all of them, must still leave the commnnication with many of the warehousing districts of London very incomplete; and that therefore recourse must still be had to conveyance by cart through some of the most crowded thoroughfares.

" To facilitate the transfer of goods, not only between

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the northern railways and the commercial parts of London, but between the northern and southern railways respectively, and thereby to make the communication between all parts of the country complete, it would be necessary that the line which we have suggested should cross the river to the west of the metropolis, to connect itself with the South-western, South-eastern, and any other lines that may approach the town on that side. The course which it should take has not come specifically under our consideration, inasmuch as it would certainly lie beyond the limits laid down in our instructions; but we have no hesitation in saying that such a line might be constructed, answering all the commercial and more important purposes of a central terminus, without being liable to the objections which arise to this latter scheme.

"We have upon this head the valuable testimony of your Majesty's Quartermaster General and of the Inspector General of Fortifications, that whilst it is of the utmost importance, with a view to the national defence, to establish an unbroken connection between the railways of the north, south, and west, a circuitous communication for this purpose round London would, for military purposes, be preferable to one which should necessitate the conveyance of your Majesty's troops or stores through a populous part of the metropolis.

"As to the interruption of important thoroughfares.—We must not dismiss this part of the subject without noticing that which forms a part of several of the projects before us—viz. the carrying a railway across the river within the metropolis. We are of opinion that there are strong reasons for discouraging such a scheme. An increase in the number of bridges already existing cannot take place without creating a new obstruction to the navigation of the river, and therefore should not be permitted except on grounds of paramount necessity. To withdraw

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from ordinary traffic, and to appropriate to the purposes of a railway any of the existing bridges, would be an inconvenience and injury to the public; and no plan which has been brought before us for adapting any of the bridges to both purposes is free from serious practical objections.

"Having now given our opinions upon each railway project which has been brought before us, and the general considerations by which we have been guided in forming these opinions, it only remains for us humbly to submit to your Majesty the following recommendations:—

"1. That on the north of the Thames no railway now before parliament, or projected, be permitted to come within the limits described in our instructions.

"That if at any time hereafter it should be deemed advisable to admit railways within those limits, this should be done in conformity with some general plan, carefully laid down under the authority of your Majesty's government, and sanctioned by the wisdom of parliament; and that under no circumstances should the thoroughfares of the metropolis and the property and comfort of the inhabitants, be surrendered to separate schemes brought forward at different times, and without reference to each other.

"5. That a communication between the railways approaching London on the north and south sides of the river, and a connection between them and the docks being desirable, this should be effected by a railway encircling the metropolis, crossing the Thames at some point west of Vauxhall Bridge, and not coming within the limits of our inquiry on the north side of the river.

Whitehall, June 27, 1846.

"(L. S.)	CANNING.
"(L. S.)	DALHOUSIE.
"(L. S.)	JOHN JOHNSON, Mayor.
"(L. S.)	J. C. HERRIES.
"(L. S.)	J. M. F. SMITH.

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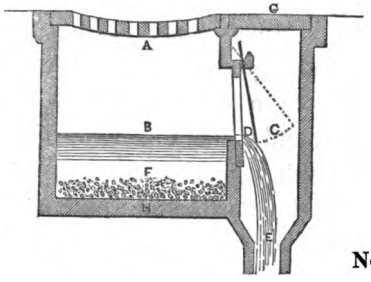
DESCRIPTION OF SEWER TRAPS, PIPES, AND MODES OF CONSUMING SMOKE.

I have in all my former publications urged that due attention be paid to obtaining a proper fall for sewers, with ample room at the outlets for the escape of the flood drainage, likewise the necessity for protecting the heads of each sewer or pipe from the entrance of any thing but water and house drainage, and that all the gully holes be protected by a trap which will at one and at the same time prevent the emission of foul air, and the entrance of silt, and contribute to the end of effectually ventilating the sewers. The following diagrams represent my patent trap, which possesses all these advantages.

No. 1.



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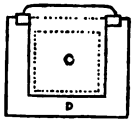
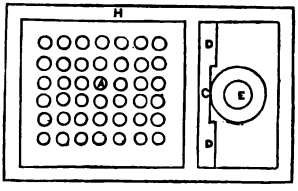


No. 1, Section.

No. 2, Ground Plan.

No. 3, Front view of Valve and Facing.

No. 2.



The trap consists of a square or oblong box, H, one side of which is divided into three parts, the lower division to

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serve as the receptacle for the silt; and the middle division, being an opening with a slate or glass valve, C, supported by nebs, or projections, formed upon the facing, D, with a recess to allow the upper part of the valve to enter, so that the lower part of the valve may open. The valve, C, is formed with projections, which, by their rounded under-edges, rest on the nebs; it will, when at rest, remain closed, but a slight pressure from the interior of the trap will press it open, whilst any pressure coming in the opposite direction will keep it effectually closed. A is the grating through which the water and silt will run, the heavy silt depositing in the box at F, whilst the water, B, presses the valve open, and flows down through the pipe, E, into the sewer. G is the cast-iron, slate, or stone top. By placing the trap under the pavement, with the opening or grating towards the gutter, the construction will be cheaper, as the paving flag will form the top of the trap. In some cases it may be preferable to use circular, square or hexagonal perforations, in place of the ordinary grating, as straws and similar substances could not so easily enter. The advantages and peculiarities of this trap are, that it allows an equally free passage for the fluid at all periods; that it prevents the houses being flooded by any rise in the sewers, whether caused by tide or land flood; that it effectually shuts out all smell or noxious air, arising from the sewers; that it is effective in both wet and dry weather, whereas preceding traps act only in wet weather, or when filled with water; that the self-acting valve affords means of perfectly ventilating the sewers; that it is most simple in construction, and easy to get at the valve in case of any obstruction or accident; and, finally, that the sewers would be protected from the entrance of heavy extraneous substances, as the silt would fall into the trap, and be thence removed at

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intervals by the scavengers, thus effecting a great saving in the cleansing of the main sewer. The trap should be made either of stone ware, slate, or brick-work with slate facing. The small sewer outlets should be faced with slate, but the large outlets should be faced with granite.

As the next important point connected with the sewers, is the best and cheapest form of pipe, it may not be out of place to insert here the following description and diagrams of my patent pipes and couplings.

The pipes may be made of cast-iron or stone ware, and of any requisite dimensions, as they are equally suitable for carrying off the collected waters of the filter land drains; for large mains and service pipes; for the conveyance of water, sewage, or gas; for the small drain leading from each house to the sewer, and to every other purpose to which pipes are applicable. The castings being all simple, and of an uniform thickness, there would be no flaws from the unequal rates of cooling; they would be lighter, and consequently easier of transport; the cylinders could be of greater length, one sixth in weight of material would be saved, and no lead would be required for joints; they would be quickly connected together or disunited; and should repairs be required, or a pipe burst at any time, the damaged part could easily be replaced without the shifting of any of the parts, or injury to the other pipe it joins; which, at present, always has to have the socket end cut off, and made good by a coupling.

The couplings are to embrace the ends of the pipe A; each extremity of the coupling should be formed with a dove-tail projection to be enclosed by a dove-tail clip, for retaining the two projections securely together. The dove-tailed projections are wider at one end than at the other; and the clip likewise is wider at one end than at the other, so that when forced on, it wedges all tightly together, and is besides more easily knocked off when it may be neces-

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sary to separate the parts. In the large cast iron pipes the thickness of the coupling should be the same as the thickness of the pipe, and the width from 6 to 8 inches, but for the smaller pipes the couplings should be broader and thinner: thus, if a pipe of 2 feet in diameter requires a coupling 6 inches broad, the pipe 1 inch in diameter, would require a coupling an inch broad, and in similar proportions, the breadth of the coupling diminishing as the diameter of the pipe increases, the largest pipes needing no greater breadth than 8 inches. Thin wrought iron coupling bands might be applied to the ordinary lead pipes instead of solder, and likewise for joining stone ware pipes.

White lead or pitch combined with tar may be used as cements for the couplings, provided the parts are sufficiently true; but if the pipes are not true at the ends, it would be necessary to surround the junction with a double band of thin felt saturated with pitch, the outer band being so placed as to pass over the junction of the inner one, and preserve an equal thickness all round, so that when the couplings are put on, the pitch would be forced into the interstices, which would thus be completely and effectually closed.

A is a section of the pipe, at the joint, each extremity having a bead, formed thereon to gauge the position of the coupling.

Fig. A.

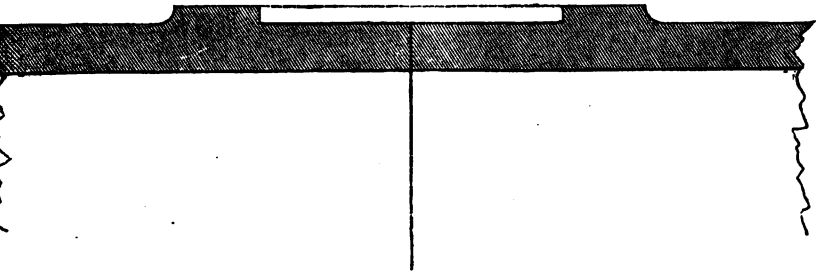

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Fig. B.—Junction of pipe, with coupling and clip on.

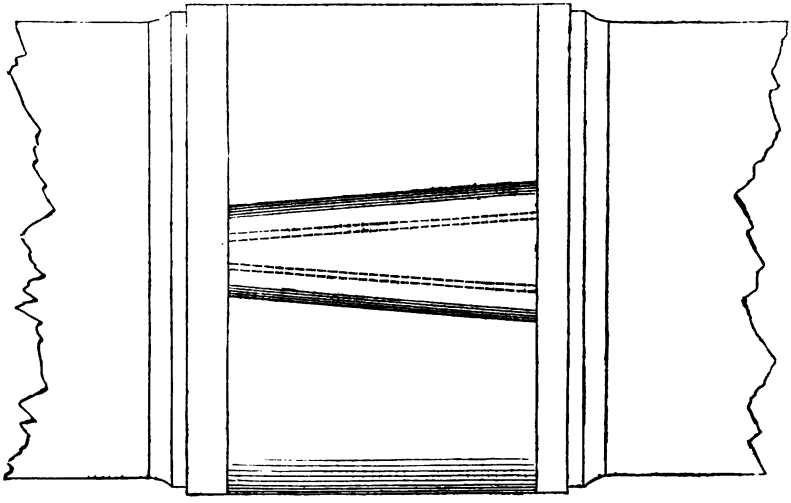

Fig C.—Section of a cast iron pipe, with wrought iron coupling, band and clip; these coupling bands may likewise be made in cast iron, see Fig D.

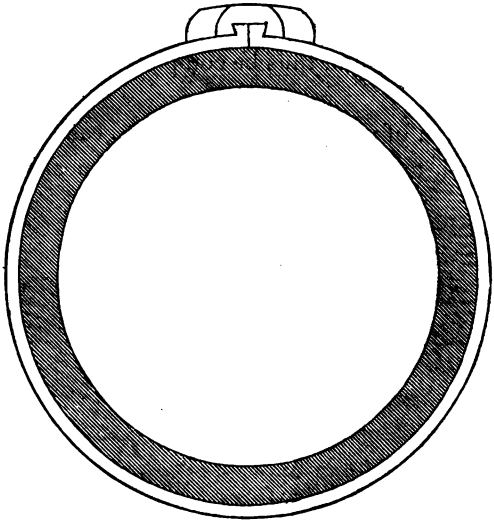

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FIG. D.

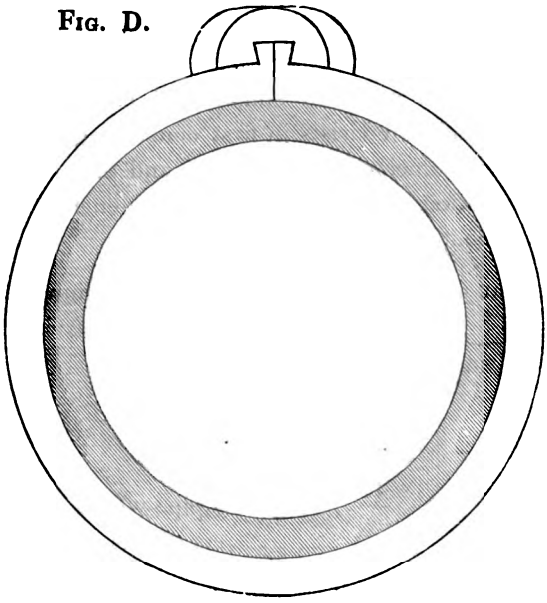
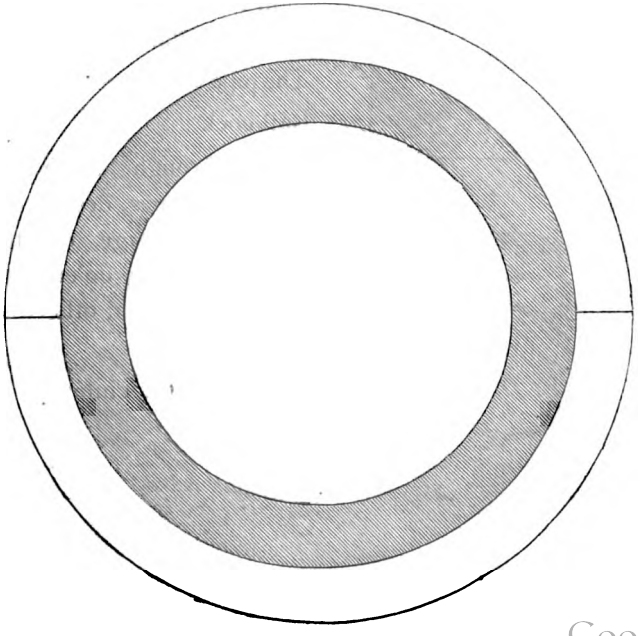


Fig. E.—Section of stone ware pipe and coupling without the clip; the coupling should be attached either by pitch or roman cement.



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As the consumption of the smoke in all factory and other chimnies has been strongly insisted upon, the following modes appear to me both simple and efficacious. In fig. F the principle consists in first consuming the smoke from the fire by means of jets of gas, and then absorbing the sulphurretted hydrogen by the steam generated in the uppermost compartment of the chimney.

Ground plan and section of chimney for consuming smoke.

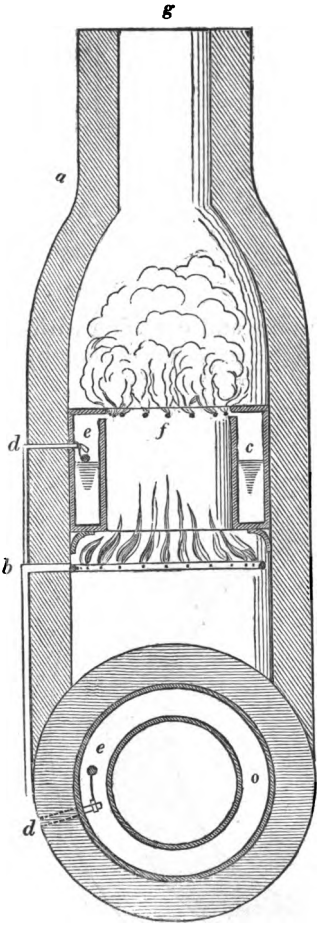

FIG. F.

a Brickwork.

b Is a pipe which discharges jets of gas at a sufficient height above the fire, thus consuming the smoke generated there.

c Is a cylindrical boiler within the chimney and above the gas flames.

d The pipe that feeds the boiler

e Ball cock.

f Holes through which the steam issues, destroying in its passage up the chimney, any deleterious gas that would otherwise escape.

g The top of the chimney.

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Chimnies on this construction would not need height, as all the smoke would be consumed within. It would be desirable for each block of buildings to have one common chimney like the above, into which the smoke from the different flues should be conducted, as it would thus be economically consumed with advantage to the whole neighbourhood.

Another mode of consuming the smoke would be by constructing the fire place or furnace in the following way.

The fire place to be divided into two unequal parts, the larger portion for the coal, and the smaller for gas; the air would enter at the fire, pass through the gas, and so on up the chimney, which need not be of an unsightly height: thus the smoke in coming in contact with the gas would be ignited and consumed, increasing the heat, and effecting a saving of fuel, of which so much is now wasted, and sent forth to poison the air in every direction.

THE END.

J. PLUMMER, PRINTER, PUDDING LANE.

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PLAN FOR VENTILATING COAL MINES,

BY

JOHN MARTIN, K. L.

Since the Sitting of the Committee of the House of Commons upon Accidents in Coal Mines, 1835, so many great and fatal explosions have taken place, as to force upon all the conviction, that the recurrence of these frightful calamities is the result solely of imperfect ventilation; and that however various and praiseworthy may have been the improvements introduced from time to time, no system has hitherto been employed which insures the security of the mines, and of the lives of the miners. As regards the continued use of the Davy Lamp, notwithstanding unfavorable experience, and Sir Humphrey Davy's own acknowledgment that it is only safe under particular circumstances, there is one point which does not seem heretofore to have been noticed:—that *the same gas will explode* more freely in proportion as the atmospheric air is purer. I arrive at this conclusion from observing, on one occasion, when I was trying the Davy Lamp, with my brother's and my own, that the former exploded when neither of the others did so; but on trying the same lamps, with the same gas, at the same place, but on another day, the whole three exploded. I then made some observations, and found that the atmosphere was much clearer, and consequently more favorable to combustion than on the former occasion; and inferring that the same principle holds good in mines, the gas there being more or less explosive, according to the state of the external atmosphere, I conclude that safety lamps should be expelled altogether; for even granting it possible to obtain a lamp safe against hydrogen, where would be the security against the more deadly choke damp?—The result of all my enquiries and experiments only establishes the conviction, that there is no remedy but such a thorough system of ventilation as would render it safe to use common candles, or gas lamps, to light the workmen; and the following plan embraces this advantage, together with efficient drainage,—greater safety during many of the mining operations—and superior economy in working the mine. Assuming the field of coal to be unworked, I

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propose to form a parallelogram, or a square of any size, say half a mile on each side, or two miles round the whole mine, as follows:— From the bottom of the down-cast shaft, two ways should be formed running close by each other, the one to go, and the other to return, till the first half is attained; these ways should then turn at a right angle to the left for another half mile to the up-shaft; this should be repeated on the left hand of the down-shaft, completing the square, and obtaining a free current round the whole mine, from the down to the up-shafts on the right, and the same on the left. To facilitate the working of this mine, the two shafts should be commenced at the same time, and the ways would thus meet each other at the intermediate angles; after which the coal should be cut away from the corners between the shafts, care being taken *never to enter the main body of the coal.* In some places it would be necessary to work by means of two and perhaps three rows of pillars, (see plan,) but the whole of the coal should ultimately be removed, excepting the row of pillars next to the surrounding gallery or outside way, which will be of value in protecting the drain, and likewise in working the next square mine when the first is exhausted. Gunpowder might safely be used with this plan, as the current of fresh air would continue to sweep the face of the works, and as fast as the gas discharges, it will be carried away by the ventilator at the up-shaft. As the open space behind the works becomes wider, the support being removed, the roof will fall in, and close up the void; but it would be of no consequence if this were not entirely closed up, since the higher end of the goaf would always be nearest to the ventilating gallery, the hydrogen gas escaping by a short and straight line to the up-shaft, and the water and carbonic acid gas running off by means of my patent tube drain to the well at the down-shaft, and thence pumped out (see plan.) Thus would be obtained the shortest, simplest, and straightest way to ventilate, drain, and carry off the coal, without danger to life from explosion, or choke damp, or chance of destruction of property; without trap-doors or men to watch them, without the necessity for inducing men to work by means of a pretended safety lamp; and last, and of no small importance to the coal-owners, without viewers paid a heavy centage for working dangerous parts of the mine. Wherever a new mine is to be opened, it should be upon this principle; though it is not absolutely necessary to form an entirely new mine for the purpose, as the principle can be applied at once to an old one without any practical difficulty.

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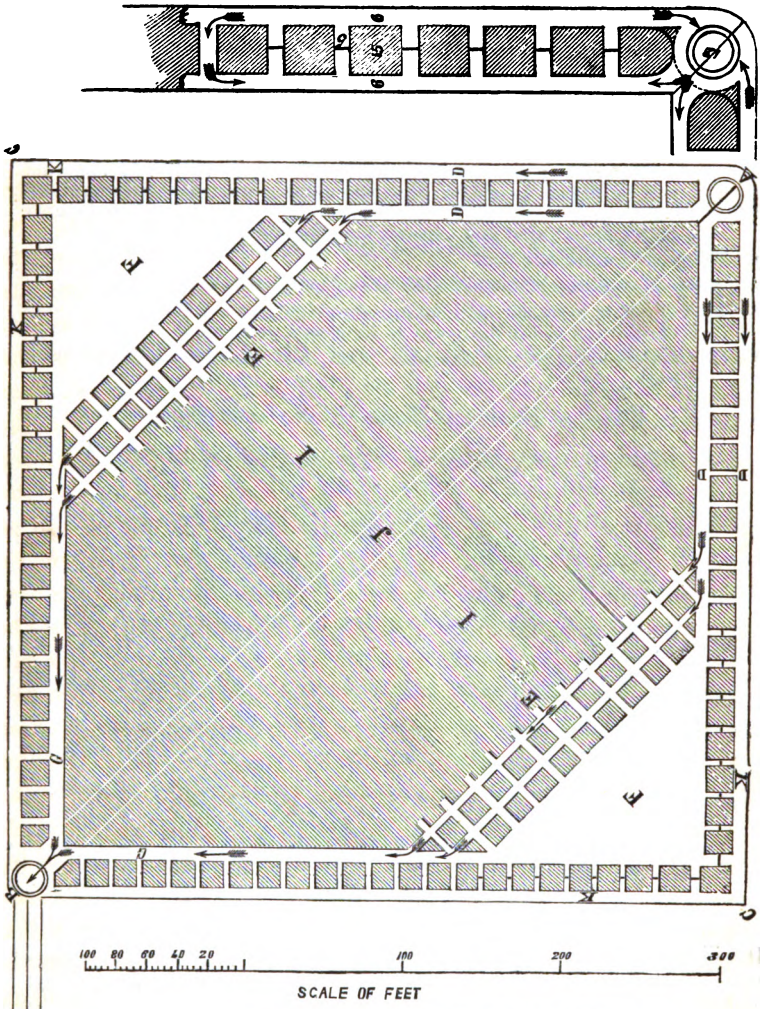


DESCRIPTION OF DIAGRAM.

A Down-cast shaft to be at the lowest level.

B Up-cast shaft at the highest level.

C The angles where the head-ways from the two shafts meet.

D The down-cast headways serving for road-way, ventilation and drainage. The ventilation will proceed down the down-cast shaft and road-way, past the face of the workings, and up the up-cast headway and shaft; and the distance being short and direct, without any recesses to retain the gas, the whole air of the mine would be changed within a few minutes.

E The face of the coal.

F **The fallen roof after the coal has been worked away.**

G **The up-cast headways.**

H **Ventilating gallery, 100 yards long, and divided into two equal parts, 2 yards wide by 3 yards high. The top of the up-shaft should be effectually**

closed to prevent the entrance of any current of air, by means of a sliding-door or valve, which should alternately close from one side of the gallery to the other, as the corves of coals enter. The plan in use, and suggested by my brother many years ago, of running the coals along an inclined railway from the mouth of the pit should be made available, for ventilating the mine, the gallery serving as an immense pump: thus to each carriage for conveying the corves should be attached a frame and door fitting exactly each separate division of the ventilating gallery, and while one carriage is going down one division full, another will be drawn up empty, thus maintaining a constant current of 600 cubic yards a minute by the alternate conveyance of full and empty carriages, without any expense for pumping off the foul air.

I The field of unworked coal

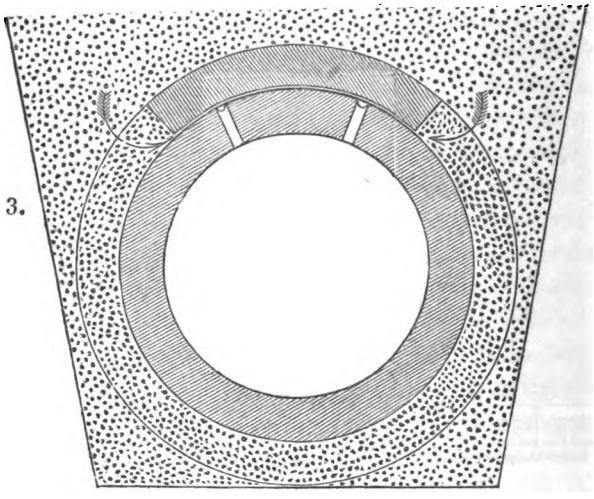
J A line of coal which should be left at the completion of the works.

K Line of pillars to be left, and having stoppings between they will serve as one portion of the head-way in forming a new mine.

Fig. 2. Enlarged diagram of down-cast shaft, and commencement of head-ways.

FIG. 3.—*Section of Tube-Drain recommended.*

FIG 3.



It will readily be seen that the merits of this plan are its extreme simplicity and completeness, that it is in no way dependant on mechanical means of drawing off, or forcing in, air; but that the great ends of ventilation, drainage, and rapid removal of the coal are attained by maintaining a short and unimpeded passage between the down and up-shafts, the whole current of air sweeping invariably past where the men are working. Thus I would substitute for the present complicated labyrinths, the numerous recesses and immense goafs in which retard and prevent the escape of the foul air, (to say nothing of the imperfect boardings, stoppings, and trap-doors, and similar costly machinery.) a simple, comprehensive, and economical system, which affords one mile of perfect safety and free circulation of air, instead of one hundred miles of intricate labyrinths containing every horror, and danger of explosion and suffocation.

LINDSEY HOUSE, CHELSEA,
1849.

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DESCRIPTION OF PLANS FOR AFFORDING AN UNLIMITED SUPPLY OF PURE WATER TO LONDON, IN CONNECTION WITH AN IMPROVED SYSTEM OF DRAINING THE METROPOLIS; FOR RESCUING THE RIVER THAMES FROM EVERY SPECIES OF POLLUTION; FOR THE SUPPLY OF SEWAGE MANURE TO THE COUNTRY; AND FOR OTHER OBJECTS OF PUBLIC UTILITY AND SANITARY IMPORTANCE.

By JOHN MARTIN, K. L.
PROJECTOR OF THE METROPOLITAN SEWAGE MANURE COMPANY,
With the Assistance of Wm. Sowerby, Jun. A. & C. E. and J. H. Jones, C.E.

SEWERAGE.—It is proposed to divide the Metropolis into convenient drainage districts, and to divert the whole of the sewage from the river, at the lowest outfalls, by means of a series of intercepting sewers adapted to the various districts, instead of the long continuous sewers originally suggested; as thus any required amount of fall can be obtained without increasing unnecessarily the depth of the sewer; and all local difficulties, such as dock entrances, blocks of public or private buildings, &c. can be avoided. The first district should comprise the diversion of the Ranelagh Sewer to the present station of the Metropolitan Sewage Manure Company, where the drainage of Brompton, Walham Green, and Fulham should, likewise, concentre, provision being made to let off the superfluous flood waters of the Ranelagh Sewer, by means of the King's Scholar's Pond Sewer. For the second district, the King's Scholar's Pond Sewer is proposed to be taken up in the Green Park, and carried thence by a direct line to the river at a point a little above Vauxhall Bridge, intercepting all the drainage of the lower levels of Westminster in its course; continuing across the Thames to South Lambeth, where the levels show that a point of discharge can be obtained as effective as at Greenwich which is seven miles lower down the river, thus securing for the Westminster drainage the means of lowest outfall and of self-acting discharge under emergency. For the central district, the drainage discharging between Westminster and Waterloo Bridges is proposed to be intercepted by a sewer, with a station in the recovered ground near Hungerford Market, for diverting the sewage to the nearest main road. For the city district, the sewer is proposed to be continued from Waterloo Bridge, along the side of the Thames, intercepting all the sewers at their lowest outfalls, until it reaches Whitefriars or Puddle Dock, where it is proposed to have the next station for diverting the sewage; the line of sewer to be continued from the station to a terminus at Irongate Stairs. The drainage of the Tower Hamlet district to be intercepted and carried down to a station in some recovered ground at Shadwell. For the Surrey side of the river, the drainage of Lambeth, Brixton, Camberwell, &c. to concentre at the Westminster drainage terminus at South Lambeth; and the drainage

of Rotherhithe, Hatcham, &c. to unite at a station near Deptford Creek. Thus the whole sewerage of the urban districts will be effectually intercepted by means of these main sewers, the longest of which would not exceed two miles in length. A station with pump engines is proposed to be placed at the termination of each line of intercepting sewer, and immediately adjacent to a tidal portion of the river, to facilitate the discharge of extraordinary flood waters, though the pumps and silt wells will be so arranged that no sewage need be wasted, whilst the run of the sewers will always be maintained. It is not proposed to interfere with the existing system of sewerage excepting in the Westminster and Kent and Surrey districts, and by making the sewers more efficient where requisite.

To relieve the drains of the lower parts of the town; the house drainage of the various suburban districts of the surrounding higher levels, should be directed to stations in the line of receiving main to be hereafter described. The surface drainage in these high levels to be separated from the house drainage, so that nothing impure may enter the higher parts of the river or its tributaries; the surface drainage within the town, however, to run into the sewers, as it is too mixed with impurities to be allowed to pollute the natural streams. This system combined with filter tube drainage of lands, and careful protection of earthy banks of springs and rivulets from washing up, will effectually prevent any impurity ever entering the sources whence the supplies of water are to be derived.

SEWAGE DISTRIBUTION.—It is proposed to convey the sewage into the country, and distribute it over the soil by a series of pipes and pumping apparatus. In dry seasons the tidal water could be used either for diluting the sewage, or for watering the land; and by a further application of the same system, sea water could be supplied inland for baths, and for agricultural purposes. The arrangement of the pipes to be as follows:—To strike a circle round London of a radius of five miles, and upon convenient elevations near the range of the circle, to place the first country sewage depôts at distances of about five miles apart, mains are to lead from the central town stations *direct* to these depôts, which should likewise be connected with one another by a main laid from depôt to depôt, with a water and sewage receptacle at every station, constituting in effect a continuous chain of elevated reservoirs round the whole metropolitan district. The service pipes are to issue from the distributing main in parallel lines half a mile apart, are to have taps disposed at angles of 60°, to which gutta percha hose

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could be attached for distributing the fluid over the soil. The sewage mains or radii should be continued in direct lines to the upland country, the bands of distributing main intersecting them at intervals of six miles (see diagrams); each point of intersection having a reserve depôt, from which either water, sewage, or both mixed, could be directed right or left at pleasure. The surrounding mains are proposed to be driven from low points of the river towards the uplands, the first and second bands taking up tidal water; and the third, sea water; and by extending the bands yet farther an unlimited supply of fluid manure could be afforded without depriving the upper part of the Thames or other natural streams of their waters. The surrounding bands would also, facilitate the diverting of the sewage of country towns, the drainage being directed to the pump well of the nearest sewage station upon the line of main. Hills instead of obstacles to the system would be most advantageous, since by pumping to reservoirs upon their summits, all the surrounding valleys will be commanded, and ample room for such reserves will be found in remote country districts where the manure is of most value.

WATER SUPPLY.—The river being relieved of all sewage, it is next proposed to separate the tidal water and pollution attending the shipping and constant traffic in so great a port, from the upper portion of the stream, and to afford thence an uninterrup'ed and inexhaustible supply of pure water to every part of the Metropolis—To improve the banks of the river—To maintain the stream sufficiently deep to be at all times navigable close to the quays, and to form convenient landing places. To effect these objects a weir is proposed to be constructed at London Bridge; by which means the whole of the upper part of the stream and its tributaries would be retained as inexhaustible reservoirs of bright running water, fit for every domestic purpose. The foundation and piers of the present bridge are proposed to be taken advantage of to form part of the foundation of the proposed weir; the stairs and landing places of the bridge would work commodiously without additional approaches being necessary; and the weir would besides protect the foundations of the bridge, as well also as the foundations of the other bridges higher up the river, and assist to prevent farther settling. The top of the weir is proposed to be constructed so as to afford a broad landing platform at each side of the river, both above and below the bridge, that below, rising and falling with the tide, but that above being a solid fixture, with sufficient spaces left to allow the water to flow underneath, so that the

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platform will extend under the end arches of the bridge like a firm dry flooring, with ample spaces for landing communicating directly with the bridge stairs. The weir to be as high as the highest tide known, but backed to the level of Trinity high water mark; the centre arch to be made with one large lock, and the one on each side adjoining the centre arch, to have two smaller locks in each. As regards the water supply, the river and its tributaries being thus rendered continuous reservoirs, the supply could be taken up at any point; it is, therefore, proposed to use the present engines of the West Middlesex Water Works, and on the south side of the river to use the engines of the Southwark Water Works, for lifting the water; and to adopt a similar system for water supply to that described for distributing the sewage—*i. e.* to lay a main direct to the high lands near Hampstead on the north, and near Norwood on the south; thence descending towards the east, filling the existing mains and collateral branches in their course, a constant and efficient high pressure supply being afforded even to the attic stories of all the houses by means of the encompassing main.

To preserve a constantly changing supply of running water to the Tower, St. Catherine, and London Docks, the tidal water should be entirely excluded, and a main laid from that part of the river immediately above the weir direct to the docks, and as nothing but pure water could enter, the expense of cleansing the docks would thus be saved. In addition to this the banks of the river are proposed to be raised where requisite, and lined with slate planking; recess docks removed; and all marshy, and ill drained lands bordering on the river improved by procuring the discharge of their superabundant waters into lower outfalls (see plans).

TIDAL CHANNEL.—In order to effectually accomplish all the above objects, of procuring a lower outfall for the drainage, entire diversion of the sewage from the Thames, and separation of every species of pollution from its waters; as well as to remove any objections that may be raised on the score of interrupting the traffic on the river—it is proposed to extend and improve the Grand Surrey Canal, by converting it into a tidal channel: thus—to commence the channel at a point in the river Thames near Deptford Dock Yard; thence in a regular serpentine direction following the ancient bed of the river, making use of the existing canal and works, so far as expedient and possible, and reclaiming such parts as are not so taken, to a point above Vauxhall Bridge. It is farther proposed to extend this channel right on to Wandsworth, where the river Wandle would be diverted from the

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Thames to flow henceforth in the new channel: from Wandsworth the line could proceed to Barnes, Mortlake and Richmond; thence by a culvert under the Thames, and by a straight course up to Staines, or even Datchett. Locks are to be placed at the before-named places, to enable vessels to enter the main stream, and likewise to allow a portion of the pure water of the river to enter the channel when the tide is low, so as to preserve a wholesome current at all times, and to let off extraordinary flood waters. It is not proposed to lock the channel at the lower end, but to afford to the trade upon it all the advantages of a tidal river. By means of this new channel the required improvement of the drainage of the Westminster, Surrey and Kent districts would be efficiently secured, as it affords a lower natural outfall without involving great lengths of sewer: a lower outfall for the whole drainage of the low levels between Greenwich and Staines, would be given—a beautiful stream of running water would be obtained, passing for a considerable distance through a densely populated district, where the accommodation of water communication would increase the facilities of commerce: it will relieve the upper part of the river of much objectionable traffic by abridging the distance between Staines and Greenwich one half, that is from 40 to 20 miles, diminishing the length of voyage from two days to less than one; the tidal action will be sent 20 miles higher up the river, with two locks instead of seven, and the river itself being backed to high water-mark these locks will not require to be high: the navigation will never be interrupted, as at the same time that the trade is carried inland by the tide in the channel, the outward bound can descend by the main stream, and vice versa; it would greatly augment the value and sanitary condition of the adjoining property, and of the entire district through which it passed, which would be yet farther improved by forming promenades with plantations of trees upon its banks, where vacant space would allow. Thus a great portion of the ancient channel of the river will be made to resume its old purpose, and by forming the new works of sufficient depth, with secure cuttings and banks, the healthful drainage of the district would be permanently secured, and the channel appear, and actually be, like a natural running and tidal river; whilst the Thames itself will realize the descriptions of our poets—

"Though deep yet clear, though gentle yet not dull;
Strong without rage, without o'erflowing full;"

then truly—

"free as seas or wind,
Unbounded Thames shall flow for all mankind,
Whole nations enter with each swelling tide,
And seas but join the regions they divide;
Earth's distant ends our glory shall behold,
And the new world launch forth to seek the old."

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GAS.—Amongst the principal nuisances in the Metropolis are the Gas Manufactories, generally situated in densely populated neighbourhoods; and it is, therefore, suggested, to incorporate the whole of the numerous gas works now within and around London, into two grand stations, one on each side of the river, as low down as Barking Creek on the left banks, and between Greenwich and Woolwich on the right, leaving the existing gas-holders in their present situations, these low points being convenient for the landing of the coal; saving the colliers employed in supplying the gas works from 12 to 20 miles of sailing; thus removing both a noxious manufacture, and the accompanying objectionable trade to a thinly peopled locality distant from London. All chymical works, bone boiling and crushing operations, potteries, furnaces, and trades which constitute in themselves pernicious nuisances should be carried on in the neighbourhood of the gas manufactories, as by simplifying and concentring all the objectionable trades at this one point, remote from town and at a low part of the river, no foul refuse could ever pollute the stream above the tidal action, and the sanitary condition of the thickly peopled Metropolis would be improved; it is, however, to be imperatively urged, that every nuisance belonging to such works, should be as strictly prevented as if they were within the town, for desirable as it may be to improve the sanitary state of the town, it must not be done at any avoidable sacrifice of that of the country. In existing manufacturing localities, all nuisance from smoke and foul refuse could be effectually prevented; thus—instead of the numerous and costly chimnies of the present system the smoke of each factory could be conducted into one common flue discharging into a single chimney, like a campanile, and there disinfected and destroyed by the means proposed by Mr. Sowerby, in his system for ventilating sewers; the flue serving also to ventilate all the premises communicating with it. The sewage of all the factories should, likewise be intercepted by one common sewer, and the combination of arrangements would facilitate the economic supply of hot and cold water to the separate works, such situations as Barking Creek and the banks of the tidal channel offering peculiar advantages for the working of the system.

Desirable as it may be to consolidate the management of the whole Sanitary Regulations of the Metropolis, it is still more essential to lay down a comprehensive system upon which the various improvements should be carried out. It was with this view that my Metropolis Improvement Plan was originally promulgated, though the practicability of effecting any one of the objects either in part or wholly was strongly impressed, I never failed to urge that the portion so taken should be

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The following estimates showing the cost of each separate part of the plan have been furnished by my professional coadjutors Messrs. Wm. Sowerby, Jun. and J. Hodgson Jones.

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Canal Cuttings	£155,466	
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Lindsey House, Chelsea, London.

1850.

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10

OUTLINE

OF

A COMPREHENSIVE PLAN

FOR

DIVERTING THE SEWAGE OF LONDON AND WESTMINSTER FROM THE THAMES AND APPLYING IT TO AGRICULTURAL PURPOSES,—FOR IMPROVING THE NAVIGATION OF THE RIVER,—AND FOR ESTABLISHING A SUPPLY OF PURE WATER TO THE METROPOLIS.

BY JOHN MARTIN, K.L.

PROJECTOR OF THE METROPOLITAN SEWAGE MANURE COMPANY.

LONDON:

EFFINGHAM WILSON, ROYAL EXCHANGE.

1850.

Price 2d.

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Entered at Stationers' Hall.

PRINTED BY JOHN PLUMMER, PUDDING LANE, EASTCHEAP.

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NOTE.—The Plan described in the accompanying pamphlet is revised in accordance with the levels officially supplied last autumn; it has not, however, been laid before the Commissioners of Sewers, but I have duly apprised them of my readiness to submit it, in detail, as the plan forwarded in August last was prepared without the advantage of the data subsequently furnished.

Since the publication of my pamphlet the Commissioners have brought up a Report upon all the Plans received prior to December 15, 1849; and though it is intimated that the Report is not conclusive as regards the decision upon the general question, still the tenor of the document so manifestly indicates a fixed intention to maintain and confirm the discharge of the sewage into the Thames, that it behoves all who are interested in Sanitary Improvement to combine in protesting against *any measures* of which the pollution of the river is a fundamental principle; and against the irrecoverable wasting of a large property so valuable as the sewage would be if distributed over the soil.

As an individual I humbly enter my protest on public grounds; but I likewise protest on the special part of the Metropolitan Sewage Manure Company, in which, as the Projector I hold so large a stake, against *any proposal* that shall contravene their Act, as explained in the Preamble.

"Whereas it is expedient and desirable to preserve and render available for agricultural purposes the drainage that now falls into the river Thames from the public Sewers of London, Westminster, and the vicinity, and thereby greatly add to the produce of the country."

"And whereas the above object will be best effected by executing the works necessary to carry out the same in *successive portions or sections*."

"And whereas the several persons hereinafter named, together with other persons, are willing and desirous to carry out the said objects, limiting their first operations in the first instance to the King's Scholars' Pond Sewer and the Ranelagh Sewer. May it therefore," &c. &c. &c.

Or that shall render futile the Resolution passed at the Court of Sewers, March 1st of the present year.

"That the Court regards with satisfaction the efforts made by the Sewage Manure Company to distribute the Sewage Water and Manure, and thereby remove from the Thames, where it is noxious, matter which spread over the land is found to be most beneficial and fertilizing."

"The Court will afford to the Company, and to all parties engaged in effecting this useful object, every facility and encouragement consistent with the important interests confided to the care of the Commission."

JOHN MARTIN.

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PREFACE.

The following pages contain, as the title indicates, merely an "outline" of the series of plans, which I have prepared with a view to aid in carrying forward that improved system of sanitary regulations, which has lately occupied so large a share of public attention. The plans, which I have in view, are the result of a long and patient study of the great question of Drainage and Water Supply as applied to the Metropolis; and I am now fully prepared to prove their practicability and to carry them into effect, if I am favored with that degree of support from the Government and from the Public at large, which the vast importance of the proposed improvement urgently demands.

Much as I desire to obtain the sanction and support of public opinion, I should have preferred to submit my plans, in the first instance, solely to the Commissioners of Sewers, rather than have had recourse to the present brief and necessarily imperfect publication, were I not anxious *to establish my claim to originality of design,* which just now bids fair to be quite smothered by a host of newly created competitors. If the information which I have received be correct, it is a positive fact that, out of the whole of the plans (upwards of 160) which have recently been submitted to the Commissioners of Sewers, there is not one with any pretension to feasibility, which is not, either wholly or in part, a plagiarism from some one or other of my published plans. This is no mere supposition of my own; for Sir Henry De La Beche distinctly stated, at a late meeting of the Commissioners of Sewers, that *my suggestions could alone lay claim to originality of design.* In proof of the justice of this claim, I may perhaps be allowed to observe,

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that, so far back as the year 1828, I published "A Plan for supplying the cities of London and Westminster with Pure Water, together with the details of a Proposition for securing the Thames from the admission of Sewage, and rendering it available for Manure." It is clear, therefore, that I, at all events, am no new competitor in the field of invention.

From the date of the above publication until the present time (now well nigh 22 years) I have devoted my attention to the important questions of Drainage and Water Supply. As a portion of my general plan, I projected, and carried to a successful issue, the formation in 1846 of "the METROPOLITAN SEWAGE MANURE COMPANY," which had secured to it by Act of Parliament the Sewage of an important district of the Metropolis,—a Company, which, although hitherto almost ruined by bad management, may yet, by a timely application of the pruning knife of reform, become useful to the public at large, and profitable to the Shareholders. If ever there was a time, when such a Company might hope to prosper, or when the originator of such a Plan as that set forth in the following pages might reasonably hope for success, that time is now present. Public opinion (long sluggish, if not entirely dormant) is at length thoroughly aroused upon the question of sanitory reform; and it is quite certain, that some comprehensive scheme of Metropolitan Drainage and Water Supply *must* soon be adopted. Having so long "borne the burden and heat of the day," I venture to hope that my matured plans may receive both from the Government and the Public that support and encouragement, which in this noble country is rarely witheld from inventive skill, and which certainly should not be witheld from inventive skill, which aims at the general good.

JOHN MARTIN.

LINDSEY HOUSE, CHELSEA,
March 11*th*, 1850.

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OUTLINE OF A PLAN

FOR

IMPROVED METROPOLITAN DRAINAGE AND WATER SUPPLY.

Before I enter upon a detail of my proposed Plan, or rather series of Plans, I beg to state that I have been professionally assisted in the preparation of it by Mr. W. Sowerby, Jun, A.C.E. and also by Mr. J. H. Jones, C.E.; and I desire thus publicly to record the obligation, which I am under to each of them.

---

1. SEWERAGE.

It is proposed to divide the Metropolis into convenient drainage districts, and to divert the whole of the sewage from the river, at the lowest outfalls, by means of a series of intercepting Sewers adapted to the various districts, instead of the long continuous Sewers originally suggested; as thus any required amount of fall can be obtained without increasing unnecessarily the depth of the Sewer; and all local difficulties, such as dock entrances, blocks of public or private buildings, &c. can be avoided.

The first district should comprise the diversion of the Ranelagh Sewer to the *present station of the Metropolitan Sewage Manure Company*, where the drainage of Brompton, Walham Green, and Fulham should, likewise, concentre,—provision being made to let off the superfluous flood waters of the Ranelagh Sewer, by means of the King's Scholar's Pond Sewer. For the second district, the King's Scholar's Pond Sewer is proposed to be taken

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up in the Green Park, and carried thence by a direct line to the river at a point a little above Vauxhall Bridge, intercepting all the drainage of the lower levels of Westminster in its course; continuing across the Thames to South Lambeth,[B] where the levels show that a point of discharge can be obtained as effective as at Greenwich which is seven miles lower down the river;—thus securing for the Westminster drainage the means of lowest outfall and of self-acting discharge under emergency. For the central district, the drainage discharging between Westminster and Waterloo Bridges is proposed to be intercepted by a Sewer, with a station in the recovered ground near Hungerford Market,[C] for diverting the sewage to the nearest main road. For the city district, the sewer is proposed to be continued from Waterloo Bridge, along the side of the Thames, intercepting all the sewers at their lowest outfalls, until it reaches Whitefriars or Puddle Dock,[D] where it is proposed to have the next station for diverting the sewage; the line of Sewer to be continued from the station to a terminus at Irongate Stairs.[E] The drainage of the Tower Hamlet district to be intercepted and carried down to a station in some recovered ground at Shadwell.[F] For the Surrey side of the river, the drainage of Lambeth, Brixton, Camberwell, &c. to concentre at the Westminster drainage terminus at South Lambeth; and the drainage of Rotherhithe, Hatcham, &c. to unite at a station near Deptford Creek.[G] Thus the whole sewerage of the urban districts will be effectually intercepted by means of these main Sewers, the longest of which would not exceed two miles in length. A station with pump engines is proposed to be placed at the termination of each line of intercepting Sewer, and immediately adjacent to a tidal portion of the river, to facilitate the discharge of extraordinary flood waters, though the pumps and silt wells will be so arranged that no sewage need be wasted, whilst the run of the Sewers will always be maintained. It is not proposed to interfere with the existing system of sewerage excepting in the Westminster and Kent and Surrey districts, and by making the Sewers more efficient where requisite.

In order to relieve the drains of the lower parts of the town the house drainage of the various suburban districts of the surround-

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ing higher levels, should be directed to stations in the line of receiving main to be hereafter described. The surface drainage in these high levels to be separated from the house drainage, so that nothing impure may enter the higher parts of the river or its tributaries; the surface drainage within the town, however, to run into the sewers, as it is too mixed with impurities to be allowed to pollute the natural streams. This system combined with filter tube drainage of lands, and careful protection of earthy banks of springs and rivulets from washing up, will effectually prevent any impurity ever entering the sources whence the supplies of water are to be derived.

2. SEWAGE DISTRIBUTION.

It is proposed to convey the sewage into the country, and to distribute it over the soil by a series of pipes and pumping apparatus. In dry seasons the tidal water could be used either for diluting the sewage, or for watering the land; and by a further application of the same system, sea water could be supplied inland for baths, and for agricultural purposes. The arrangement of the pipes to be as follows:—To strike a circle round London; of a radius of five miles, and upon convenient elevations near the range of the circle, to place the first country sewage depôts at distances of about five miles apart, mains are to lead from the central town stations *direct* to these depôts, which should likewise be connected with one another by a main laid from depôt to depôt, with a water and sewage receptacle at every station, constituting in effect a continuous chain of elevated reservoirs round the whole metropolitan district. The service pipes are to issue from the distributing main in parallel lines half a mile apart, with taps disposed at angles of 60°, to which gutta percha hose could be attached for distributing the fluid over the soil. The sewage mains or radii should be continued in direct lines to the upland country, the bands of distributing main intersecting them at intervals of six miles *(see diagrams)*; each point of intersection having a reserve depôt, from which either water, sewage, or both mixed, could be directed right or left at pleasure. The surrounding mains are proposed to be driven from low points of the river

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towards the uplands, the first and second bands taking up tidal water, and the third, sea water; and by extending the bands yet farther an unlimited supply of fluid manure could be afforded without depriving the upper part of the Thames or other natural streams of their waters. The surrounding bands would also, facilitate the diverting of the sewage of country towns, the drainage being directed to the pump well of the nearest sewage station upon the line of main. Hills instead of obstacles to the system would be most advantageous, since by pumping to reservoirs upon their summits, all the surrounding valleys will be commanded, and ample room for such reserves will be found in remote country districts where the manure is of most value.

3. WATER SUPPLY.

The river being relieved of all sewage, it is next proposed to separate the tidal water and pollution attending the shipping and constant traffic in so great a port, from the upper portion of the stream, and to afford thence an uninterrupted and inexhaustible supply of pure water to every part of the Metropolis—to improve the banks of the river—to maintain the stream sufficiently deep to be at all times navigable close to the quays, and to form convenient landing places.

In order to effect these objects a WEIR is proposed to be constructed at London Bridge; by which means the whole of the upper part of the stream and its tributaries would be retained as inexhaustible reservoirs of bright running water, fit for every domestic purpose. The foundation and piers of the present bridge are proposed to be taken advantage of to form part of the foundation of the proposed Weir; the stairs and landing places of the bridge would work commodiously without additional approaches being necessary; and the Weir would besides protect the foundations of the bridge, as well also as the foundations of the other bridges higher up the river, and assist to prevent farther settling. The top of the Weir is proposed to be constructed so as to afford a broad landing platform at each side of the river, both above and below the bridge,—that below, rising and falling with the tide, but that above being a solid fixture, with suffi-

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cient spaces left to allow the water to flow underneath, so that the platform will extend under the end arches of the bridge like a firm dry flooring, with ample spaces for landing communicatting directly with the bridge stairs. The Weir to be as high as the highest tide known, but backed to the level of Trinity high water mark; the centre arch to be made with one large lock, and the one on each side adjoining the centre arch, to have two smaller locks in each. As regards the water supply, *the river and its tributaries being thus rendered continuous reservoirs*, the supply could be taken up at any point; it is, therefore, proposed to use the present engines of the West Middlesex Water Works, and on the south side of the river to use the engines of the Southwark Water Works, for lifting the water; and to adopt a similar system for water supply to that described for distributing the sewage—*i. e.* to lay a main direct to the high lands near Hampstead on the north, and near Norwood on the south; thence descending towards the east, filling the existing mains and collateral branches in their course, and affording a constant and efficient high pressure supply even to the attic stories of all the houses by means of the encompassing main.

To preserve a constantly changing supply of running water to the Tower, St. Catherine, and London Docks, the tidal water should be entirely excluded, and a main laid from that part of the river immediately above the Weir direct to the docks, and as nothing but pure water could enter, the expense of cleansing the docks would thus be saved. In addition to this the banks of the river are proposed to be raised where requisite, and lined with slate planking; recess docks removed; and all marshy, and ill drained lands bordering on the river improved by procuring the discharge of their superabundant waters into lower outfalls (*see plans*).

4. TIDAL CHANNEL.

In order effectually to accomplish all the above objects, of procuring a lower outfall for the drainage, entire diversion of the sewage from the Thames, and separation of every species of pollution from its waters; as well as to remove any objections that

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may be raised on the score of interrupting the traffic on the river—it is proposed to extend and improve the Grand Surrey Canal, by converting it into a tidal channel: thus—to commence the channel at a point in the river Thames near Deptford Dock Yard; thence in a regular serpentine direction following the ancient bed of the river, making use of the existing canal and works, so far as expedient and possible, and reclaiming such parts as are not so taken, to a point above Vauxhall Bridge. It is farther proposed to extend this channel right on to Wandsworth, where the river Wandle would be diverted from the Thames to flow henceforth in the new channel: from Wandsworth the line could proceed to Barnes, Mortlake and Richmond; thence by a culvert under the Thames, and by a straight course up to Staines, or even Datchett. Locks are to be placed at the before named places, to enable vessels to enter the main stream, and like wise to allow a portion of the pure water of the river to enter the channel when the tide is low, so as to preserve a wholesome current at all times, and to let off extraordinary flood waters. It is not proposed to lock the channel at the lower end, but to afford to the trade upon it all the advantages of a tidal river. By means of this new channel the required improvement of the drainage of the Westminster, Surrey and Kent districts would be efficiently secured, as it affords a lower natural outfall without involving great lengths of sewer: a lower outfall for the whole drainage of the low levels between Greenwich and Staines, would also be given—a beautiful stream of running water would be obtained—passing for a considerable distance through a densely populated district, where the accommodation of water communication would increase the facilities of commerce.

This plan will likewise relieve the upper part of the river of much objectionable traffic by abridging the distance between Staines and Greenwich one half, that is from 40 to 20 miles, diminishing the length of the voyage from two days to less than one; the tidal action will be sent 20 miles higher up the river, with two locks instead of seven, and the river itself being backed to high water-mark these locks will not require to be high: the navigation will never be interrupted, as at the same

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time that the trade is carried inland by the tide in the channel, the outward bound can descend by the main stream, and vice versa; and it would moreover greatly augment the value and sanitary condition of the adjoining property, and of the entire district through which it passed, which would be yet farther improved by forming promenades with plantations of trees upon its banks, where vacant space would allow.

By the above means a great portion of the ancient channel of the river would be made to resume its old purpose, and by forming the new works of sufficient depth, with secure cuttings and banks, the healthful drainage of the district would be permanently secured, and the channel appear, and actually be, like a natural running and tidal river; whilst the Thames itself would realize the descriptions of our poets—

> "Though deep yet clear, though gentle yet not dull;
> Strong without rage, without o'erflowing full;"

then truly—

> " free as seas or wind,
> Unbounded Thames shall flow for all mankind,
> Whole nations enter with each swelling tide,
> And seas but join the regions they divide;
> Earth's distant ends our glory shall behold,
> And the new world launch forth to seek the old."

GAS.

Among the principal nuisances in the Metropolis are the Gas Manufactories, which are generally situated in densely populated neighbourhoods. It is, therefore, suggested to incorporate the whole of the numerous gas works now within and around London, into two grand stations, one on each side of the river, as low down as Barking Creek on the left banks, and between Greenwich and Woolwich on the right, leaving the existing gas-holders in their present situations, these low points being convenient for the landing of the coal; saving the colliers employed in supplying the gas works from 12 to 20 miles of sailing; and thereby removing both a noxious manufacture and the accompanying objectionable trade to a thinly peopled locality distant from London. All chymical works, bone boiling and crushing operations, potteries, furnaces, and trades which constitute in them-

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21½ miles of Piping.....	92,400	
30 miles Connecting Band	132,000	
Six large Depôts	180,000	
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WEIR AT LONDON BRIDGE, with Locks to the three middle Arches.....		£198,000

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The time required for the completion of the whole of the above works, if commenced simultaneously, would be about 18 months.

By dividing the total amount of cost into several Sewage Manure Companies, a moderate capital only would be required for each; whilst it would seem but just that the Metropolis, which benefits by the diversion of the sewage, should bear the expense of the intercepting sewers, and arrangements for conveying it to the first band,—namely, £649,986.

It has been suggested to me, that my plans are too comprehensive for the public mind, and too costly for the public purse, collapsed as it is by recent Railway ruin. I entertain a widely different opinion. The public mind which could comprehend, and the public purse which could pay for, the existing system of Railway communication, will surely be able to comprehend and to pay for the simple and comparatively unexpensive Plan, which I have now suggested.

JOHN MARTIN.

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REPORT

OF THE

FIRST MEETING

OF THE

METROPOLITAN

SEWAGE MANURE COMPANY,

INCORPORATED 1846.

TOGETHER WITH AN

ANALYSIS OF EVIDENCE,

&c.

OFFICE—7 WATERLOO PLACE.

LONDON:
PRINTED BY HATTON AND CO., KING ST. COVENT GARDEN.

1846.

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Directors.

J. C. BLAIR WARREN, Esq., Horkesley Hall, Colchester—*Chairman*,

CHARLES EDWARD LAYARD, Esq., 89 Great Portland Street.—*Deputy Chairman.*

JOHN MARTIN, Esq., K.L., 30 Allsop Terrace, New Road.—*Projector.*

EDWARD WILLIAM COX, Esq., 1 Torrington Square.

HENRY PETER FULLER, Esq., 112 Piccadilly.

WILLIAM AUGUSTUS GUY, Esq., M.B., 15 Bloomsbury Square.

THOMAS HODGKIN, Esq., M.D., 9 Brook Street, Hanover Square.

CHARLES JOPLING, Esq., 4 Pelham Crescent, Brompton.

JOHN LE CAPPELAIN, Esq., 45 Edwardes Square, Kensington.

GEORGE H. PINCKARD, Esq., 78 Great Russell Street, Bloomsbury Square.

FRANCIS SHERBORN, Esq., East Bedfont, Middlesex.

Consulting Agricultural Chemist.

Professor BRANDE, F.R.S., Royal Mint.

Civil and Agricultural Engineer in Chief.

JAMES SMITH, Esq., of Deanston, 13 Queen Square, Westminster.

Engineer.

WILLIAM C. MYLNE, Esq., F.R.S., Civil Engineer, and Engineer to the New River Company.

Architect.

CHARLES FOWLER, Esq., 1 Gordan Square.

Solicitors.

Messrs. BAILEY, SHAW & SMITH, 5 Berners Street.

Secretary.

JOHN JAMES MOORE, Esq., 3 Queen Square, Bloomsbury.

Offices.

7 WATERLOO PLACE.

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EXTRACT

FROM THE REPORT OF THE

Select Committee of the House of Commons,

CONSISTING OF

Mr. BINGHAM BARING.	Mr. WILLIAM HAMILTON.
Mr. HAWES.	Mr. KEMBLE.
COLONEL FOX.	Mr. BRAMSTON.
COLONEL THOMAS WOOD	Mr. BENJAMIN SMITH.
LORD ROBT. GROSVENOR.	Sir WILLIAM CLAY.
Mr. TOWER.	Mr. DUNCAN.
Sir DE LACY EVANS.	Mr. REDHEAD YORKE.
Mr. BERNAL.	

ON METROPOLITAN SEWAGE MANURE,

JULY 10th, 1846.

Your Committee cannot conclude their Report without urging upon The House the importance of a project which proposes at all times to carry away the drainage at the level of low tides, and to remove from the Thames the daily increasing refuse of London. It is true that this measure has lost something of its efficiency, in consequence of the abandonment of the reservoirs. The result of this concession is, that no more sewage can be drawn at any time from the drains than can be disposed of at the moment to the agriculturist; but even this comparatively imperfect measure will try a great experiment, and if the confident expectations of Your Committee are accomplished, it will not fail ultimately to realize all the advantages which were originally contemplated. Mr. Dickinson has proved the efficiency of liquid manures. The meadows of Edinburgh and of Mansfield have shown the power of Sewage Water. Mr. Thompson, of Clitheroe, and Mr. Harvey, of Glasgow, have established the fact—that liquid manure may be applied at a cheap rate, by means of the mechanical contrivance of service-pipes and hose, to crops in every stage of their growth.

There will be found individuals, no doubt, in this country of enterprise, to give further development to each of these experiments; but it is only through the agency of a Company that they may be all combined, and applied to the important purposes of cleansing our towns, purifying our rivers, and enriching our soil.

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EXTRACT FROM A REPORT

ON THE

METROPOLITAN

SEWAGE MANURE COMPANY'S BILL,

By Sir H. T. DE LA BECHE, GEORGE STEPHENSON, Esq., and Dr. LYON PLAYFAIR.

Presented to Parliament by Her Majesty's Command, 14th May, 1846.

"We fully appreciate and agree in the principle,—that the sewage of towns should be applied, wherever practicable, to the production of human food, instead of being wasted and lost, as is now too frequently the case. We are aware that the loss sustained in this manner by London and its environs is enormous, and we view the employment of the Metropolitan Sewage as an object highly deserving public attention and support."

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COPY OF A PETITION,

Presented to the HOUSE OF COMMONS *by parties locally interested in the success of the* METROPOLITAN SEWAGE MANURE COMPANY.

"The humble Petition of the Undersigned persons, being Land-owners, Farmers, Market Gardeners, and Inhabitants, in the districts proposed to be supplied with Liquid Sewage Manure by the Metropolitan Sewage Manure Company,

SHEWETH,—That a Bill is now depending in your Honourable House, intituled, "A Bill to incorporate a Company, by the name of the Metropolitan Sewage Manure Company."

"That the very great value of the Liquid Sewage Manure has already been fully proved.

"That your Petitioners are convinced that the measures, proposed to be effected by the said intended Company, will be of great service to your Petitioners, both on account of the highly fertilizing qualities of the manure, and of the cheapness with which, owing to the facility of its transit and application, it can be supplied.

"That your Petitioners are therefore most desirous that the said Bill should pass into a Law.

"Your Petitioners, therefore, humbly pray your Honourable House, that the said Bill may receive your favourable consideration, and that the same may pass into a Law.

"And your Petitioners will ever pray, &c."

[Here follow the signatures of Francis Sherborn and George Fagg, Farmers, Bedfont, and nearly 300 other persons, owning or cultivating upwards of 40,000 acres of land.]

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FORM OF APPLICATION FOR SHARES.

TO THE DIRECTORS OF THE METROPOLITAN SEWAGE MANURE COMPANY.

GENTLEMEN.—*I hereby request you to allot me* *Shares in the above Company, and I undertake to accept the same, or any less number that may be allotted to me, and to pay the deposit of* £1 *per Share thereon, and to execute the necessary deeds that may be required.*

Name _____

Address _____

Profession or Business (if any) _____

Reference _____

Address to Messrs. Bailey, Shaw, and Smith, Solicitors, 5 Berners Street, Oxford Street, London.

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FIRST REPORT

OF THE

METROPOLITAN

SEWAGE MANURE COMPANY.

THE first meeting of the Shareholders under the Act of Incorporation obtained this Session, was held on Thursday, September 17, in the British Hotel, Cockspur street, at twelve o'clock.

J. C. Blair Warren, Esq., of Horkesley Hall, Essex, occupied the Chair, and in opening the proceedings, said that he felt it a high honour to have been selected by his brother Directors to fill that position, on the occasion of the first meeting of the Company. The importance of the subject was such, that it was impossible at present to see all its ramifications, and the manner in which it would ultimately benefit London, as well as the adjacent country, by the removal of the obnoxious substances which created so much disease in the town, and the application of which to the land fertilised and enriched it, thus combining the health of the one with the increased productiveness of the other. He believed that their own Company would be merely the commencement of a great reform in this particular, and that, however large the benefits it might confer directly, it would bestow still greater by causing the formation of similar Companies in other parts of the country. His principal duty, however, was to refer to the Report, which would be read by the Secretary; and he could not but congratulate them on the triumph they had achieved, after an arduous and protracted struggle. They had not been backed in their efforts by men of rank, nor by the moneyed interests of the country, but they had been sustained in their endeavours by the consciousness that they were acting rightly, and having full faith in their cause, they had persevered; and, above all, they had faith in their officers, who had enjoyed the confidence of the public for some time past, especially Mr. Smith, of Deanston, their civil and agricultural engineer in chief, Professor Brande, their consulting agricultural chemist, and Mr. Bailey, their solicitor. They felt that, under such generalship, they

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could fight a good battle. They were also under great obligations to Mr. Martin, the originator of the Society. Indeed, the public at large were deeply indebted to him for having for so many years, by his purse and his individual exertions, endeavoured to create a practical interest on this important subject. In the Report it would be found that there was a recommendation as to the remuneration which should be awarded to that gentleman. The Directors had been extremely cautious in the spending of money, but they were at the same time anxious that justice should be done to those to whom they were so much indebted, and that when the public were reaping benefits from the exertions of these parties, they themselves should participate in the fruits of their own labours to an extent commensurate with their exertions and the benefits conferred. Mr. Martin, with that modesty and generosity which has characterised his whole course, had, however, requested that the question of compensation to him should be postponed until after the shareholders had received a dividend of four per cent. upon their capital, and that it should then be left entirely to them to say in what shape they would award that compensation to which he was so justly entitled. After some further remarks, the Chairman concluded by calling upon Mr. Moore, the Secretary, to read the Report, which was as follows:—

REPORT.

The Directors have the satisfaction to Report that the Act of Parliament has been obtained, by which the Company is now incorporated, and the requisite powers secured for carrying their object into effect.

It has been deemed expedient to make some concessions, tending to modify the original plan, in order to meet the various misconceptions naturally attaching to a novel undertaking, but these modifications will not materially affect its efficiency.

It is well known that the grand object of this scheme is to render the whole of the Sewage Water of the Metropolis available for the important purpose of fertilizing the adjacent country, and, by economising a valuable material hitherto wasted, to open out a new source of wealth.

It has been deemed expedient in the present instance to commence with the King's Scholars' Pond Sewer and

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Ranelagh Sewer, as forming the first section of the great plan. The main pipe is to be carried as far as Hounslow, whence, by means of service pipes, the fluid will be distributed in all directions over an extensive tract of country.

It is highly encouraging to find, that in regard to the district now proposed to be supplied, an earnest desire has been expressed by the occupiers of land, to the extent of upwards of 40,000 acres, to become large consumers of the fluid, and that the country is well adapted for its application.

It is worthy of remark, as evincing the high opinion entertained of this measure, that notwithstanding the unfavourable time at which it was brought out—viz., on the eve of the Railway Panic—sufficient support was obtained to enable the promoters to proceed to Parliament with their Bill.

The discussions which took place in the House of Commons on the occasion of the first reading of the Bill, and the great interest then excited, led to the appointment of a Select Committee, instructed to investigate the whole subject on public grounds; and the careful and searching inquiry which ensued, resulted in a Report most favourable to the Company's Plan, as will appear from the following extract:—

"Your Committee cannot conclude their Report without urging upon the House the importance of a project which proposes at all times to carry away the drainage at the level of low tides, and to remove from the Thames the daily increasing refuse of London. It is true that the measure has lost something of its efficiency, in consequence of the abandonment of the reservoirs. The result of this concession is, that no more Sewage can be drawn at any time from the drains than can be disposed of at the moment to the agriculturist; but even this comparatively imperfect measure will be a great experiment, and if the confident expectations of your Committee are accomplished, it will not fail ultimately to realize all the advantages which were originally contemplated. Mr. Dickinson has proved the efficiency of liquid manures. The meadows of Edinburgh and of Mansfield have shown the power of Sewage Water. Mr. Thomson, of Clitheroe, and Mr. Harvey, of Glasgow, have established the fact, that liquid manure may be applied at a cheap rate, by means of the mechanical con-

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" trivance of service-pipes, and hose, to crops in every " stage of their growth.

" There will be found individuals, no doubt, in this " country of enterprise, to give further development to " each of these experiments; but it is only through the " agency of a Company that they may be all combined, " and applied to the important purposes of cleansing our " towns, purifying our rivers, and enriching the soil."

It is due to the professional gentlemen hitherto engaged in carrying forward the proceedings of the Company, to acknowledge the zealous and efficient services rendered by them on every occasion, which, together with the assistance of numerous friends and supporters, have been the means of surmounting great difficulties, and carrying the Bill triumphantly through Parliament. Under these circumstances, your Directors have not hesitated to secure the permanent services of the following gentlemen as Officers of the Company.

Civil and Agricultural Engineer in Chief.

James Smith, Esq. of Deanston, 13, Queen Square, Westminster.

Engineer.

William C. Mylne, Esq., F.R.S., Civil Engineer, and Engineer to the New River Company.

Consulting Agricultural Chemist.

Professor Brande, F.R.S. Royal Mint.

Solicitors.

Messrs. Bailey, Shaw, and Smith, 5 Berners Street.

Secretary.

John James Moore, Esq. 3 Queen's Square, Bloomsbury.

Notwithstanding that the salaries of the Directors, Auditors, Treasurer, and Secretary, are left by the Act of Parliament to the decision of the Shareholders, the Shareholders might wish for some report or recommendation on these points from the Directors; but from the short time which has elapsed since the passing of the Act, the Directors would prefer postponing their report on these matters until the next General Meeting, when the services required, and the affairs of the Company generally, will have been more developed, and at which Meeting a Balance Sheet of

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the receipts and expenditure, after having been examined and approved by the Auditors, now to be appointed, will be submitted. As regards the Directors themselves, they have no intention of taking anything for their past services, and they will continue to give their best attention to the interests of the Company until the General Meeting in February next, when the subject of remuneration will be left entirely in the hands of the Shareholders.

Besides the claims above alluded to, it is proper to state that there is a claim, not of the same definite nature, but equally just and unquestionable in principle—namely, the compensation due to Mr. John Martin, as the original projector of the Company.

On this subject the Directors have great pleasure in stating to the Shareholders, that it is the particular wish of Mr. Martin, that whatever compensation he may be deemed entitled to, should arise out of the success of the undertaking, and be payable only out of the profits, and not until they shall have yielded an annual dividend of 4 per cent.

The Directors, therefore, beg to recommend to the Shareholders, that they should recognize the claim of Mr. Martin to compensation, reserving the amount and mode of payment for future consideration.

Hitherto, in all their proceedings, the closest attention has been paid by the Provisional Committee and Directors to limit expenditure and economize the Funds of the Company,—a principle which should be scrupulously adhered to on all occasions.

The Directors have further to report, that they have taken steps for completing the number of the Shareholders, and that within the last week alone, the applications for shares have been so numerous, as to leave no doubt of the early completion of the Share List.

In conclusion, the Directors beg to congratulate the Shareholders on the prospects of the Company. The public is becoming more and more alive to the importance of the undertaking; prejudices and misconceptions are fast disappearing before the light of experience; the parties locally interested display an increasing desire to avail themselves of the great advantages about to be placed within their reach; and the original promoters of the Company are constantly receiving fresh confirmation of the soundness of their plan, and fresh reasons for perse-

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vering in an undertaking which is recommended by so many weighty considerations, and which, in subserving the interest of town and country, promises an ample return for the investment of capital.

Mr. Neison moved that the Report be approved and adopted; and in so doing paid a high compliment to the directors and officers for the manner in which they had conducted the business, as well as to Mr. Martin, for his indefatigable exertions, and disinterested conduct. With respect to the proposed operations of the Company, and the nature and value of the material with which they intend to deal, the subject had been so frequently and so ably treated by Mr. Smith, Dr. Guy, and others better qualified than himself to do justice to its importance, that he would not do more than express his deep conviction of its great utility, and his belief that the Company would, by its success, reconcile great public benefits with individual advantage.

Mr. Propert, in seconding the motion, remarked that this was a subject of very great importance; it had engaged his attention for several years. The means which he thought of for effecting the object were not the same as those proposed by the Company; he was, however, glad to co-operate with the Company in carrying out the undertaking. Mr. Martin deserved great credit for his indefatigable perseverance.

Mr. Jellicoe and Mr. Owen Jones were appointed Auditors to the Company.

Mr. James Smith, of Deanston, the eminent agriculturist, on rising to give notice of a motion as to the future meetings of the Company, said, that he would take that opportunity of offering a few observations relative to the objects contemplated by the Metropolitan Sewage Manure Company, and the reasons which had induced him to connect himself with the undertaking. It was not a project taken up by him in a few days, but it had engaged much in his attention for a period of twenty-five years, as well of considering the mechanical means of relieving towns of their sewage, as in applying that invaluable fertilizer to the purposes of agriculture. But though he had devoted his attention for so long a period to the subject, he had

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not till recently practically tested the results on a sufficiently large scale to satisfy the many prejudices he knew he must encounter in bringing the system into operation. He had made strenuous exertions during the last two years to have these experiments made on a sufficiently large scale, and he had induced some friends to co-operate with him in his views. It was first tried by Mr. Thompson, of Clitheroe, in the year 1844, and the success was complete, but it was on too small a scale to form an example sufficiently strong to satisfy the prejudices of the public. Subsequently, however, he persuaded Mr. Harvey, the extensive distiller of Glasgow, to make an experiment of a larger character. Mr. Harvey, having a powerful steam-engine on his premises, had the means of testing the value of the system. Besides this, having a large number of cows on his premises, he had a vast quantity of the best liquid manure to apply to the purposes of irrigation. Besides this, his distillery afforded a vast quantity of other valuable fertilizing matter, which was previously entirely wasted. Acting on his (Mr. Smith's) suggestions, Mr. Harvey laid down pipes by which he diffused this liquid over a surface of upwards of 300 acres. In the first instance, through a mistaken notion of economy, Mr. Harvey only laid down pipes of two inches diameter, which were found to be much too small, and the material too slight; but having relaid this with a pipe of five inches diameter, and of stronger fabric, the conveyance of the liquid to the fields was effected in the most satisfactory manner. An Irish labourer, at two shillings a-day, was found perfectly able to distribute the liquid conveyed to the field, over from two to three acres; and it was, therefore, perfectly obvious to every man practically acquainted with agricultural operations, that this was an immense saving over the present mode of distributing manure. The results of the fertilizing process were equally satisfactory and remarkable. He (Mr. Smith) visited one of the fields which had been subjected to the process in December last, and he found forty-three bullocks up to the fetlock in long rich close-growing pasture, on a stiff clay soil; and Mr. Harvey had been enabled to cut the grass for his cows three or four times in the course of the season. With regard to wheat, oats, and turnips, the same satisfactory results had followed. In a field, where one part had been manured with the liquid, and the other had not, the difference was truly remarkable.

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In the one instance, it was stunted; in the other, it had double the amount of straw, and of grain in the ear. From that, and from other such experiments which he had witnessed, he felt perfectly convinced of the complete success of the system, and of the great benefits which would result to the towns on the one hand, by relieving them of the sewage, and to agriculturists, by supplying one of the most valuable fertilizers. No doubt, the Company would have difficulties to encounter, but these would not be engineering difficulties, for in that respect he saw none whatever. In that department there was nothing to do but what was of the simplest character, and most easily effected. The great difficulty, at first, would be to induce those who would be most benefited by it to avail themselves of the advantage, although from the Report it seemed that that difficulty would soon be overcome, and he had no doubt they would ultimately have two customers for every one they would be able to supply. He approved of the resolution to commence operations on a limited scale, in order that, whatever errors might be committed, they might be easily remedied; but he believed that it would be for the interest of the Company to extend its operations to the largest possible field as promptly as possible. In conclusion, Mr. Smith, after expressing his sense of the honour conferred upon him, and his determination to do everything in his power to advance the interests of the Company, gave notice that at the next general meeting he would move that the half-yearly meeting be held on the first Tuesday of May and November, instead of February and August, as fixed by the Act.

In the course of some conversation arising out of the observations of Mr. Smith of Deanston, Mr. J. J. Moore, the Secretary of the Company, related the results of an experiment which had been tried at the Marquis of Westminster's mansion, to ascertain whether the application of the sewage water was attended by such an unpleasant odour as to warrant the strong prejudice in the minds of many persons against its use. The water was tried on the lawn close to the house, and so little was the Marquis aware of its application, that he asked afterwards when it was to be applied. The only thing by which the fact that it had been applied was known, was the improvement in the grass. One of the greatest difficulties that the Company had to contend with was the fear which most persons entertained that the liquid manure in its transmission and distribution

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would be a nuisance; conceiving that the unpleasant smell which issues from the gully holes in the streets, arises from the liquid in the sewers. This is a great mistake; as it is recently and considerably diluted, and not in the state of fermentation or decomposition by which alone the unpleasant smell can be produced; but it is the deposits that are left in certain places in the sewers which undergo decomposition, and throw off the noxious effluvia that are so very unpleasant. Mr. Moore also entered into various details, shewing the efficacy and utility of the plan, to which he had devoted his attention for many years. Upwards of twenty years ago he purchased a property of 600 acres, requiring improvement of every kind, and in a situation inaccessible to the cartage of manure; he had therefore in its cultivation been forced to make available all the resources that science afforded, and he had brought to bear upon it the sciences of hydraulics, mechanics, and chemistry, to the extent that they became developed as applicable to agriculture; while thus engaged, he had examined the application of liquid manure in every part of Britain. On seeing the report of Mr. Stephenson, about eighteen years back, respecting the meadows of Edinburgh, stating that they let for £30 an acre rent, he could not believe it until he went there and examined them, the result of which proved perfectly satisfactory. About six years ago he met with the account of the Duke of Portland's meadows at Mansfield, and went to see them, with which he was more astonished than even with the Edinburgh meadows, as the great value of the produce from those at Mansfield was not in consequence of their contiguity to a large town, as was the case at Edinburgh, but being an agricultural district, the produce was applied to agricultural purposes, and as such of immense value; indeed, those meadows are the most perfect specimen in the kingdom of the improvement that can be effected by the application of liquid manure. Mr. Moore then proceeded to state the results of a personal tour among the agriculturists of the district in which the Company proposed to commence operations. They laughed at the idea at first, and thought it impossible to be effected, particularly at the price the material was proposed to be supplied; but upon its being fully explained to them, they admitted its practicability, and also the very great benefits that would be conferred on the inhabitants in town and the agriculturists in the country by the Company's operations; and

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now they were most anxious for the success and practical working of the Company. The whole matter was simply a new application of existing machinery. The steam-engine, the water-pipe, and the hose of the fire-engine were the three agents employed. These were admitted to be the best and cheapest mechanical means for effecting the objects to which they are at present applied; and he could see no reason why the same kind of pipes which conveyed clean water to the town should not carry back to the country that dirty water which generated disease in the streets, lanes, and alleys, but which, applied to the land, would fertilize and enrich it. There was nothing to prevent it but want of knowledge; and it was monstrous to think that not less than one million's worth of the richest manure was annually discharged into the Thames and wasted, while, at the same time, we were sending to Africa and America for an article not superior to that which was thrown away at our own doors. He was considered by some persons too sanguine respecting the success of the undertaking. He admitted having come from a distance of about 300 miles to assist Mr. Martin and others in carrying out the object; and he was confident of success, because it was as impossible that the subject would not be taken up, as that if quartern loaves and legs of mutton were floating down the Thames and the people starving on its banks, they would not make an effort to obtain them. He considered agriculture as a manufacture of food, and that which the Company proposed saving, as the raw material from which food is to be manufactured: more than the half of that which is produced in Britain is allowed to run to waste. The measures lately adopted by the legislature, in admitting foreigners to compete with the agriculturists of this country in the manufacture of food, will compel the economizing of the raw material in every possible way; and there is no doubt that this Company will become the nucleus for the formation of Companies in every large town in the kingdom. He had already been applied to from several towns, to assist in the formation of companies for the same object; and he was confident that the time was not far distant when each town would have the means of converting into food that which is at present running to waste and generating disease.

Mr. Holgate, of Staines, said, that he could bear testimony to the anxiety of the occupiers of land, along the proposed line of the Company's operations, to obtain a

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supply of the valuable manure which it was proposed to convey to them. The farmers in his parish would take shares, to a man, partly to encourage the undertaking, and partly in the hope that by doing so they might have a preference in the supply of the liquid; for what they feared was, that the Company could not give them enough of it.

Mr. Pare then rose and said, that the proprietors had a duty to perform in voting their thanks to the Directors for the manner in which they had performed the duties confided to them. That Company was not like a Railway, a Gas or Water Company, which everybody understood. It was a new project, and had been met by all the usual prejudices which started up to oppose innovations upon accustomed modes of action. The Directors deserved the highest credit for the manner in which they had effected this object so far; and believing that the Company was one which combined at once the advantage of the town, the country, and the shareholders—in a word, "blessing him who gives and him who takes,"—he had the highest confidence in its success under such officers.

The motion was seconded by Mr. Propert, and carried unanimously.

Dr. Guy, in rising to acknowledge the vote of thanks to the Directors, said that he had originally felt a warm interest in the success of this undertaking, on account of the improvement which it was calculated to effect in the sanatory state of the metropolis; but that an examination of the plans of the Company had convinced him, that its agricultural and engineering merits were as great as its sanatory advantages. On behalf of his fellow-Directors, he begged to state that they had endeavoured to pursue an honest, prudent, and economical course, and, in common with the officers of the Company, had their hearts in the work they had undertaken. He begged particularly to allude to the great services of their Solicitor, Mr. Bailey, and to state his opinion, that had he not combined a warm interest in the object of the Company, with the most upright and conciliatory bearing as a lawyer and a man of business, the Company could not have arrived at their present triumphant position. Dr. Guy concluded by repeating, that it was the earnest wish of the Directors to conduct the affairs of the Company with care and economy.

C. E. Layard, Esq., Deputy-Chairman, having during many years' service in the Southern Continent of India and

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Ceylon, seen the effects of irrigation, where the most barren tracts had been converted into beautiful soil by its means, could not resist the temptation of aiding the spread of such a blessing to his native land, although upwards of 40 years of active labour abroad might have entitled him to repose in the evening of his life. When he had seen the most sterile soils bearing two crops in a year, he hoped to see at least the same number in this country; and as to grass, he was certain it might, by the application of liquid manure, be cut, as it had been by Mr. Dickinson, one of the witnesses before the Select Committee, ten times a-year. Mr. Layard concluded by moving the adjournment of the meeting till December 3, 1846.

Mr. Pinckard seconded the motion, and entered into some explanations of the plans adopted by the Provisional Committee, to secure the shareholders, in case of failure from all liability. He also adverted to the gratifying fact that within a few days applications for shares to a large amount had been made—an indication of the confidence which the public felt in this undertaking.

Mr. Fowler, in proposing a vote of thanks to the Chairman, adverted to the valuable assistance Mr. Blair Warren had rendered to the Company, by coming forward at an early period, when its prospects were doubtful, and taking a large number of Shares; besides giving his attendance as a Provisional director, and his influence as a large landed proprietor. Mr. Fowler also took occasion to mention his having joined Mr. Martin many years since in the endeavour to bring forward this important measure, and the gratification it afforded him, after such a long struggle with many difficulties and discouragements, to find it now crowned with success. That the promoters may be regarded as the pioneers, who have cleared the way for this great march of improvement; the advantages of which, both sanatory and economical, will be greater than can be foreseen or calculated. Mr. F. further expressed his satisfaction at having been the medium for introducing several friends, who had proved to be important instruments in carrying out the plan, particularly Mr. Bailey, whose merits had been so properly acknowledged by the Directors, and which could not be too highly appreciated.

The Motion was seconded by Mr. Hargreave, and carried by acclamation, and having been duly acknowledged, the meeting was adjourned to December 3.

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ANALYSIS OF EVIDENCE, &c.

THE present mode of cleansing and draining our large towns, and disposing of their refuse, will doubtless be regarded by the next generation with the same feelings of surprise with which we view the strange customs of barbarous people. It is a striking example, on the grandest scale, of inefficiency and extravagance. We shall search in vain for a similar instance of wholesale waste of resources. Not content with polluting our rivers, and heaping up upon their banks masses of offensive matter most injurious to health, we are constantly pouring into them treasures which cannot be estimated at a less sum than several millions a-year. In the metropolis alone, the value of the liquid refuse annually carried into the Thames, and lost to agriculture, amounts, according to the very lowest estimate, to half a million pounds, and according to the highest to little short of four millions.

To improve the drainage of the metropolis, to restore the waters of the Thames to their purity, to put a stop to the poisonous exhalations which are constantly rising from its banks, and to apply this valuable refuse to the purposes of agriculture, are the objects of the METROPOLITAN SEWAGE MANURE COMPANY.

As the application of liquid manure to agricultural and horticultural purposes, though by no means unknown to the ancients, and long practised in many parts of Europe, and for a still longer period, and more systematically, in China, has not yet come into general use in England; it has been thought that an Analysis of the valuable Evidence recently laid before the Health of Towns Commission, and before the Select Committee of the House of Commons on Metro-

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politan Sewage Manure, together with extracts from works of authority, might prove useful, not merely by shewing the security of the data on which the Metropolitan Sewage Manure Company proposes to base its operations, but by imparting instruction to agriculturists into whose hands this publication may chance to fall.

The principal results established by the quotations contained in the following analysis may be briefly stated thus:—

1. The very substances which, if allowed to collect and decompose in the midst of our large towns, give rise to fevers and other destructive diseases, may be made the source of great fertility to the surrounding country. p. 4.

2. These same substances, diluted with water, may be conveyed into the country and applied to the land with perfect safety, and less offensively than the solid manures now in use. p. 5.

3. The state of dilution in which the refuse of towns exists in the Sewer Water, is highly favourable to the growth of plants, and the increase of the fertility of the soil. p. 6.

4. The Sewer Water, which it is thus proposed to apply to the purposes of agriculture, is proved, by chemical analysis, to contain all the elements of fertility. p. 7.

5. It has a high money value. p. 11.

6. From very accurate experiments on the relative fertilizing power of different kinds of manure, it results that an equal produce may be raised by liquid manure at a far cheaper rate than by any other manure, whether domestic or foreign; and that liquid manure is consequently by far the most economical that can be made use of. p. 13.

7. Though the employment of liquid manure is, as yet, by no means general, instances of increased produce attending its use are on record, and very striking illustrations have been afforded of the increased value which it gives to land. p. 15.

8. Sewer Water has been advantageously applied, both to pasture, arable, and garden ground, and with the very best effects to a vast variety of produce. p. 18.

9. There is every reason to believe that the Sewer Water will be in large and constant demand at every season of the year. p. 23.

10. There are also certain incidental advantages attending the use of liquid manure, such as a more rapid growth of the plants watered by it, and the destruction of some kinds of insects. p. 27.

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11. It is admitted on all hands that the value of the liquid manure is such as amply to repay the expense of its conveyance. p. 27.

12. It is also proved that the conveyance by pipes is by far the most economical means of transport; and on comparing the relative expense of conveying solid and liquid manure, we arrive at the important conclusion, that the cost of conveying the liquid manure by pipes is perfectly insignificant as compared with the cost of the transport of solid manure by carts; while the cost of distributing the liquid manure over the land is but a fraction of the expense attending the application of solid manure.

13. The practicability of the plan of the Metropolitan Sewage Manure Company is proved by experiment. p. 29.

It is not pretended that the subject of the application to agriculture of the liquid manure, as collected from the sewers of large towns, is exhausted by the following analysis; but it is confidently expected that the considerations brought forward will suffice to prove the enormous value of that which is now allowed to run to waste, and the entire feasibility of the plan here proposed for its collection and distribution. Nor can it be reasonably doubted that a Company formed to effect so great a saving, and to confer so great a boon on the inhabitants of the metropolis, and on the agriculture of the surrounding districts, will receive the cordial support of the public, alive to the vast importance of providing, by a system of wise economy, for the rapid increase of our already crowded population. An annual addition to our population of 300,000 inhabitants cannot but excite the most lively apprehensions, if we continue a system of wasteful extravagance, by which the richest elements of fertility, having an acknowledged value of several millions a-year, are constantly being thrown into the sea. Unlike all other sources of manure, the refuse of towns bears a constant relation to the increase of population, and promises a perennial supply of fertilizing matter, which not only cannot fail, but must be continually on the increase.

It is but justice to Mr. John Martin to state, that he long since brought forward and enforced many of the considerations contained in the following Extracts, as the reader will perceive on referring to his "Thames and Metropolitan Improvement Plan," published in 1842.

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1. *The very substances which, if allowed to collect and decompose in the midst of our large towns, give rise to fevers and other destructive diseases, may be made the source of great fertility to the surrounding country.*

The bane of the town is the boon of the country.

"The very refuse of the materials which have served as food and clothing to the inhabitants of the crowded city, and which, if allowed to accumulate there, invariably and inevitably taint the air, and render it pestilential, promptly removed and spread out on the surface of the surrounding country, not only give it healthfulness, but clothe it with verdure, and endue it with inexhaustible fertility."—*Dr. Southwood Smith's evidence before the Health of Towns' Commission.* First Report, p. 79.

This cause of disease if properly, conveyed and applied to the country would promote abundance, cheapen food, and increase the demand for beneficial labour.

"The condition of large rural districts in the immediate vicinity of the towns, and of the poorest districts of the towns themselves, presents a singular contrast in the nature of the agencies by which the health of the inhabitants is impaired. Within the towns, we find the houses and streets filthy, the air fetid; disease, typhus, and other epidemics rife amongst the population; bringing, in their train, destitution and the need of pecuniary as well as medical relief; all mainly arising from the presence of the richest materials of production, the complete absence of which would, in a great measure, restore health, avert the recurrence of disease, and, if properly applied, would promote abundance, cheapen food, and increase the demand for beneficial labour. Outside the afflicted districts, and at a short distance from them, as in the adjacent rural districts, we find the aspect of the country poor and thinly clad with vegetation except rushes and plants, favoured by a superabundance of moisture, the crops meagre, the labouring agricultural population few, and afflicted with rheumatism and other maladies, arising from damp and an excess of water, which, if removed, would relieve them from a cause of disease, and the land from an impediment to production; and, if conveyed for the use of the town population, would give that population the element of which they stand in peculiar need, as a means to relieve them from that which is their own cause of depression, and return it for use to the land as a means of the highest fertility."—*Report of the Poor-Law Commissioners, &c.* 8vo. p. 97.

Our present supply of

"The most effectual, as well as the most economical method of restoring the balance between the town and

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country, would be to avail ourselves of that enormous accumulation of animal exuviæ which the existence of a crowded city necessarily occasions; and to convert that which is now a pabulum of disease into a source of life and abundance.

guano an imperfect substitute for the wasted manure of our towns.

"As indeed the geologists of the present day cite, as a proof of the ignorance or neglect of their predecessors, that the stone required for the fortifications at Gibraltar was brought out from England, when it might have been obtained upon the very spot; so I conceive our descendants will marvel at the inattention to chemical science evinced by the present generation of farmers, in importing from distant regions, such as South America, substitutes, and those perhaps but imperfect ones, for that fertilizing material, of which the greater part is allowed to deposit itself unprofitably in the beds of our rivers."—*On the Application of Science to Agriculture, by C. Daubeny, M.D., F.R.S. Journal of the Royal Agricultural Society.* 1842.

"Thousands of hundred-weights of those phosphates flow annually into the sea, with the Thames and with other of the British rivers."—*Liebig's Chemistry of Agriculture, &c.*

Waste of phosphates.

"It is to the use of this substance (town refuse) drawn from reservoirs in the towns, that Belgium, in a great degree, owes her fertility; while in many large cities of Germany, it is allowed to drain into the rivers. Since 1200 pounds' weight of it yearly may be reckoned for each unit of population, it is easy to see, where population is counted by millions, how important its application must be."—*Professor Sprengel, on Animal Manures. Journal of the Royal Agricultural Society.* 1840.

Source of the fertility of Belgium.

2. These same substances, diluted with water, may be conveyed into the country and applied to the land with perfect safety, and less offensively than the solid manures now in use.

"I observed, on going over the meadows (in the neighbourhood of Edinburgh) so irrigated with the Sewer Water, that the offensive smells complained of by some of the neighbouring inhabitants, as arising from the meadows, emanated mainly from the masses of decomposing matter left in the ponds, and not so much, if at all, from the water holding only fertilizing matter in solution."—*Evidence of James Smith, Esq., of Deanston. Health of Towns' Commission.* Part ii., Appendix, p. 325.

The offensive odour of Sewer Water due chiefly to the solid deposits.

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Sewer Water, in its worst state less offensive than common farm-yard manure.

"Even in its worst condition it (the Sewage Water) smells much less than the common farm-yard manure does, and being in a liquid state, it will be immediately absorbed into the soil; if there is any smell, it will be very evanescent."—*Evidence of James Smith, Esq. of Deanston. Report of the Select Committee on Metropolitan Sewage Manure*, p. 6.

Idem.

"I imagine that this Sewage Water is a much less noxious and fetid manure, than many others in present use."—*Professor Brande's evidence. Ibid.* p. 55.

No sulphuretted hydrogen generated, if the Sewer Water is applied in the recent state.

"I do not think, if it were dispersed over the surface of the earth so as to be imbibed and soaked into the soil, that any sulphuretted hydrogen would be generated. It is merely where it is kept stagnant and in quantity, and where the organic matter has an opportunity of decomposing in contact with the solution, that the production of sulphuretted hydrogen ensues." *Ibid.* p. 56.

The odour disappears in half an hour.

Mr. J. Knight, in answer to the question, "How soon does the smell go off after the use of it?" says, "I think you find very little of it, perhaps, in half an hour." *Ibid.* p. 48.

3. The state of dilution in which the refuse of towns exists in the Sewer Water is highly favourable to the growth of plants, and the increase of the fertility of the soil.

Dilution lessens the odour, and increases the value of the manure.

Dr. Lyon Playfair, speaking of some imperfect attempts to apply the refuse of towns, made in the case of Preston and Bury, says:—"This," the failure of the attempts, "is mainly owing to the want of dilution of the refuse, which not only would prevent the escape of odour, but also render the manure more fit for reception by the plants."—*Evidence before the Health of Towns' Commission.* Part ii., Appendix, p. 46.

The chief difficulty at Edinburgh, the want of water to dilute the Sewerage.

I had a correspondence with Mr. Oliver, a very scientific agriculturist who unfortunately is no more, one of the most able men in Scotland, who had a portion of the irrigated meadows near Edinburgh, and he stated that their great difficulty was the want of water, the means of dilution. It appeared, when I visited Edinburgh, from the testimony of better judges, because practical judges, that that was about their chief difficulty, getting a command of water to dilute and apply the Sewer Water with the best effect. When the Sewer Water was first run on, it appeared to be (as the Duke of Portland described to me the

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water on his irrigated meadows), of the consistency of "turtle soup;" after it had run over about 40 acres, and had deposited the matter in suspension, it appeared to be as transparent nearly as toast and water. The grass at the extremity of the irrigation, where the liquid manure is in this last condition, appears to be of a finer and better quality. If they could have obtained the free command of plain water, they would probably have used it to dilute the Sewer Water, and apply it in the diluted state more frequently.—*Evidence of E. Chadwick, Esq. Report of Select Committee of the House of Commons, on Metropolitan Sewage Manure*, p. 109.

Land irrigated by Sewer Water free from deposit, produces the best grass.

"The more you dilute, the more you gain in efficiency within some limit as yet unascertained." *Ibid.* p. 109.

Virtue of dilution.

"Certainly that extent of dilution that prevents the escape of any offensive emanations, indicates the best state in which the manure is preserved, and the state in which it is best applied." *Ibid.* p. 109.

Idem.

"The high tide flows up a great way to the Hammersmith road, and beyond that; and the market gardeners let a great quantity in of the water from that creek, and they take care to let it in at the time the tide rises, which is bringing up all the drainage from London; and they use it to a great extent; in fact, they saturate the earth with it, and with such effect that they seldom use a water-pot." —*Mr. Knight's evidence, ibid.* p. 50.

When diluted by the water of the river, highly productive.

"In so far as my experience of the application of Sewer Water goes, I think that Sewer Water could stand considerable further dilution."—*Evidence of James Smith, Esq., ibid.* p. 64.

The Sewer Water will bear further dilution.

"If we had the Sewage water as it comes from the houses, it would be much too strong; we are the better for the water."—*Ibid.* p. 4.

Too strong as it comes from the houses.

4. *The Sewer Water which it is thus proposed to apply to the purposes of agriculture is proved by chemical analysis to contain all the elements of fertility.*

These salts, as they are derived in great measure from the excretions which have passed into the sewer, are principally composed of the ashes of our bodies, resulting from the food we have digested; and as we have received these salts either directly from plants, or indirectly through animals from plants, it is evident they must be the food of plants; and plants receive these substances from the soil,

Source of the contents of the Sewer Water.

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which they must gradually exhaust. Now, amongst these substances, we find three which are especially valuable to plants; of these three, the most important is ammonia; ammoniacal salts exist in these waters to a considerable extent:—and in addition to these, we have alkaline salts, potash, and common salt; potash is not so abundant as common salt:—and in the third place, earthy phosphates, containing the whole phosphoric acid. I mention these three compounds in particular, because they are substances that are found in the soil in but small quantities, and yet are absolutely essential to the maintenance of vegetable life. The quantity of potass which passes out of this sewer per day (estimating the average discharge of the sewer at about thirty gallons in a second, so that the average daily discharge would be about two millions and a half of gallons), the average quantity of potass would be about a ton weight, and about the same quantity of phosphates of the earths pass off every day; *i. e.*, about a ton of phosphoric acid, in combination with lime and magnesia, emptied from this sewer every day in waste. Of ammonia there is more than that, nearly double that quantity, nearly two tons of ammonia. The two analyses differ in some respects; the ammonia varies. In one case I find about a ton, and in the other about two tons per diem. In the case where the water was stopped by flood-gates, which I consider the fairest average of the two, I find as much as two tons turned out into the Thames per day; the quantity will vary according to the season."—*Evidence of Professor Miller, of King's College. Report of Select Committee on Metropolitan Sewage Manure, p.* 38.

The quantity of potash, phosphates, and ammonia, daily passing into the Thames from the King's Scholars' Pond Sewer: Potash 1 ton, phosphates 1 ton, ammonia 1 or 2 tons.

An analysis of one average specimen of Sewer Water, by Dr. Miller, gave the following results:—

Matters in solution and suspension in the water of the King's Scholars' Pond Sewer.

Matters in solution, per gallon, 45 grains, 6 tenths.
Matters in suspension, ditto, 44½ grains.

A second average specimen, examined by Dr. Miller, gave a larger proportion of both constituents.

A specimen of Sewer Water collected at four different times of the day, from the King's Scholars' Pond Sewer, analyzed in the laboratory of King's College, gave the following results:—

Matters in solution, per gallon, 80 grains.
Matters in suspension ditto 1000 grains.

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A specimen examined by Messrs. Brande and Cooper was found to contain—

Matters in solution, per gallon . 85 grains.
Matters in suspension, ditto . 55 grains.

An analysis of the Sewer Water of Edinburgh, made by Mr. Philips, of the Museum of Economic Geology, gave— Edinburgh Sewerage.

Solid matters in solution . . 83 grains.
Solid matters in suspension . 244 grains.

An analysis of the same water, by Mr. J. T. Cooper, gave—

Matters in solution . . . . 78 grains.
Matters in suspension . . . 79 grains.

Mansfield undiluted sewage was found to hold 77 grains of matter in solution. Mansfield Sewerage.

From this comparative analysis, it may safely be inferred that the sewage of the King's Scholars' Pond Sewer is as rich in soluble matters—to which, mainly, the sewage water owes its value—as the sewerage of Edinburgh or Mansfield, from which such surprising results have been obtained (See p. 15).

The following minute analyses will show the substances held in solution and suspension:—

KING'S SCHOLARS' POND SEWAGE (AVERAGE).

Analyzed by Messrs. Brande & Cooper.

One gallon of the liquid portion, evaporated to dryness, gave 85·3 grains of solid matter, 74·8 of which was again soluble, containing— Analysis of Messrs. Brande and Cooper.

Ammonia	3·29
Sulphuric acid	0·62
Phosphate of lime	0·29
Lime	6·05
Chlorine	10·00

and potassa and soda, with a large quantity of soluble animal and vegetable matter. And 10·54 was insoluble.

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The insoluble portion, produced by evaporation of the liquid, weighed 10·54, and consisted of -

Phosphate of lime	2·32
Carbonate of lime	1·94
Silica	6·28
	10·54

The deposit from a gallon weighed 55 grains, of which 21·22 grains were combustible, and consisted of animal matter rich in nitrogen, some vegetable matter, and a quantity of fat; and 33·75 of matter, consisting of—

Phosphate of lime	6·81
Oxide of iron	2·01
Carbonate of lime	1·75
Sulphate of lime	1·53
Earthy matter and sand	21·65
	33·75

KING'S SCHOLARS' POND SEWAGE (AVERAGE).

Analyzed by Professor Miller.

Professor Miller's analysis.

Ammonia	3·26
Phosphoric acid	0·44
Potash	1·02
Silica	0·54
Lime	7·94
Magnesia	1·87
Common salt	13·66
Sulphuric acid	7·04
Carbonic acid	4·41
Combustible matter, containing 0·34 nitrogen	5·80
Traces of oxide of iron	—
Matters in solution . . .	55·98
Matters in suspension consisting of combustible matters, sand, lime, and oxide of iron	44·50

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5. *The Sewer Water has a high money value.*

Value of the Sewage Water which flows into the Thames from the King's Scholars' Pond Sewer.

Ammonia in a state of salt is worth, at the lowest computation, 16*s.* a cwt. Now, upon the low computation that only one ton of ammonia (which is equal to three tons of any salt of ammonia) passes off into the Thames each day from this sewer, 48*l.* worth would be thrown away; in the same way, about a ton of earthy phosphates, or bone earth, the commercial value of which is not less than 3*l.* a ton; say the same for the potash thrown off; we shall have 54*l.* worth passing off every day, actual money value. The quantity of solid matter in suspension, say it amounts even to double the quantity I have found (I have found nearly 50 grains per gallon), say 100 grains, would yield daily about 16 tons (of course taking for granted that the calculation of the delivery of this sewer is correct); it would yield daily 16 tons of solid matters in suspension, which at 10*s.* per ton would be worth only 8*l.*; so that we have for the liquid manure an excess of value of 46*l.* over the solid.

The daily loss is 54*l.* for the liquid; and the total loss would be about 64*l.*

Annual value of its chief constituents, £23,360.

(According to this calculation, the annual value of the chief constituents of the Sewage Water, which at present passes into the Thames from the King's Scholars' Pond Sewer, is £23,360; and of that which flows from all the Sewers of London, on the supposition that the fluid they discharge is of equal strength, £433,879.)—*Evidence of Professor Miller. Report of Select Committee*, p. 41.

The excretions of one man valued at £1 17*s.* a year.

"Human excrements contain (with the exception of one ingredient, silicate of potash) all the conditions essential to fertility. . . . In fact, when we recollect that a pound of urine contains all the ingredients necessary for the production of a pound of wheat, it seems incredible folly to allow all the valuable refuse to run to waste in our large towns, and to send whole fleets to Ichaboe and the Incas, for what we are wasting at home. In Flanders, where much manure is used, the collected excrements of a man for one year are valued at 1*l.* 17*s.*"—*Dr. Lyon Playfair. Health of Towns' Commission.* Part ii., Appendix, p. 47.

The Sewer-Water of towns calculated to yield a clear revenue of £1 a head.

"Taking a general view of the subject, we may assume a clear revenue from the Sewer Water of all towns of 1*l.* for each inhabitant, either in a direct money return, or partly to the inhabitants in a reduced price, from the increased abundance of produce."—*Evidence of J. Smith, Esq., of*

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Deanston. Health of Towns' Commission. Part ii., Appendix, p. 328.

Saving due to Sewer Water as compared with guano or farm-yard manure.

"I have ascertained that the quantity of Sewer Water due to a town of 50,000 inhabitants amounts to about 1,190,080,946 gallons per annum, which quantity will yield an annual application of 17,920 gallons per acre to an extent of 66,410 acres. Taking the average cost of guano and farm-yard manure at *2l.* per acre, and deducting *12s. 9d.*, the cost of the application of the Sewer Water, there will appear a saving due to the Sewer Water of *1l. 7s. 3d.* per acre; allowing one half thereof to go to the farmer, there will remain a free income due to the Sewer Water of 45,241*l.*, which is nearly 1*l.* per head of the population."—*Evidence of James Smith, Esq., of Deanston. Report of the Health of Towns' Commission.* Part ii., Appendix p. 328.

The night-soil a valuable perquisite in Belgium.

I entertain no doubt, that when administrative improvements admit of sanatory arrangements being carried out, it may be worth while to pay the householder at the least *10s.* a head for the refuse of his house, instead of half-a-crown, as the farmer does. I think they pay him—the highest price I have heard has been something like *10s.* for the refuse of a house, he carting it away; and I believe, either in rates or rents, *10s.* a head might be paid. The truth is, in Belgium for the solid manure they pay as much as *1l. 17s.* per head—for the liquid and solid manure of an adult. At Bruges, I found that it is considered a very valuable perquisite. I was told a housemaid of all work might be got for *3l.* a year wages, and the night soil."—*Evidence of E. Chadwick, Esq. Report of the Select Committee of the House of Commons on Metropolitan Sewage Manure,* p. 111.

The sandy wastes of Flanders and Holland fertilized by the refuse of towns.

"The London drainage would be most valuable; we should be independent of all the guanos or foreign manures, if we could obtain it in anything like a concentrated form. Flanders and Holland thrive in the most marvellous manner, owing entirely to that; they are fertilizing every year several thousands of acres of floating, blowing sand, which becomes compact, and produces the most abundant crops of potatoes, and afterwards corn of every description. It is, in fact, the best and most important manure that I am acquainted with, containing all the elements that Liebig tells you that land requires under different sorts of cultivation."—*Dr. Granville's Evidence.* Ibid. p. 69.

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"The city of Paris gets a clear revenue of 800,000 francs from the right of allowing certain persons to empty and carry away the night-soil, which is conveyed to Montfauçon."—Ibid. p. 67.

The refuse of Paris a source of revenue to the city.

"The solid substances contained in urine, if all added to the land, would be more fertilizing than guano, which now sells at 10*l.* a ton. If we estimate the urine of each individual on an average at only 600 pounds, then there is carried into the common sewers of a city of 1,000 inhabitants a yearly weight of 600,000 pounds, or 270 tons of manure, which at the present price of guano is worth £2700; which would no doubt prove more fertilizing than its own weight of guano, and might be expected to raise an increased produce of not less than 1,000 quarters of grain."—*Johnson's Lectures on Agricultural Chemistry.*

Urine more fertilizing than guano.

6. *From very accurate experiments on the relative fertilizing power of different kinds of manure, it results that an equal produce may be raised by liquid manure at a far cheaper rate than by any other manure, whether domestic or foreign; and that liquid manure is consequently by far the most economical that can be made use of.*

A Mr. Thompson, at Clitheroe in Lancashire, was induced to fit up a small pumping apparatus; he has a village there and a bleach work, where there is a great deal of soapsuds and sewage matter from the village generally. At my recommendation, he fitted up pumps, and with pipes conveyed it over his pasture land; and in order to test before he had gone on with his operations what was likely to be the result, he applied eight tons of liquid manure to a given extent of land, to an acre; to another acre he put fifteen tons of common farm-yard manure in the usual way of dressing; to another acre he put a quantity of guano—three cwt. of guano. The result was, that the grass which was raised by this Sewage Water was superior to the grass raised either by the guano or by the common farm-yard manure, fifteen tons against eight. It must be taken into account that the liquid manure which he used was better than the common Sewage Water."—*Evidence of James Smith, Esq. of Deanston. Report of Select Committee on Metropolitan Sewage Manure*, p. 13.

Eight tons of liquid manure (soapsuds and sewage matter) superior to *fifteen* tons of farm-yard manure, and *three* cwt. of guano.

"I had another set of experiments made at Stirling, which gave very interesting results. I employed a person there upon whom I could rely to make the experiment for

Results of a similar comparison at Stirling.

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me. He laid out some land in rather a sandy loamy soil; laid out portions; first a division he manured with farm dung and ashes mixed, at the rate of 12 tons per acre, and at a cost of 48*s*. A second portion, with the same compost, giving 16 tons per acre, and at a cost of 64*s*. A third division, with guano, 2 cwt., costing 16*s*. A fourth with guano, 4 cwts. per acre, at a cost of 32*s*. Another ridge, similar in extent to the whole of this, was manured with Sewer Water, at the rate of 16 tons per acre, and taking it at 3*d*. per ton, the cost would be 4*s*. The average produce (the different specimens were not ascertained separately), the average produce of the whole variety, the dung and guano averaged 45 bushels per acre of good barley. That with the Sewage Water averaged 42 bushels per acre, showing that this small quantity of 16 tons had the effect of coming very nearly up to the dung and the guano, but showing also that more liquid manure might be given with safety. There was a small piece tried without manure at all. The piece tried without manure only gave 30 bushels. The section which was raised from the 16 tons of mixed manure, and from the 4 cwt. of guano, both of them were rather overgrown, and were laid in consequence of their great growth. That which was raised by the Sewage Water was not so heavy as to be laid; but it approximated very nearly to the bulk of the others."—Ibid. p. 13.

Relative cost of Sewer Water and Guano.

Two-and-a-half cwt. of guano, applied annually to an acre of land, would induce a very rich condition of the soil, especially when conjoined with the farm-yard manure always available, and would even tend, in a course of years, to increase very much the amount of this description of manure. Taking the quantity of water necessary, from analysis, to furnish 5 cwt. of fertilizing matter, at 17,920 gallons per acre, I give below an estimate of the cost thereof; I give also an estimate of the cost of supplying double that quantity, equal to 5 cwt. per acre of guano or 30 tons of farm-yard manure.

Cost of manuring one acre with Sewer Water .	0	12	9
Ditto with Guano, 2½ cwt. at 8s.	1	0	0
Ditto with farm-yard manure, 15 tons at 4s. .	3	0	0
Sewer Water is cheaper than Guano	0	7	3
Ditto than farm-yard manure	2	7	3
Ditto than the average of the two	1	7	3

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Cost of manuring one acre with Sewer Water .	0	16	6
Ditto with Guano, 5 cwt. at 8s.	2	0	0
Ditto with farm-yard manure, 30 tons at 4s. .	6	0	0
Sewer Water is cheaper than Guano	1	3	6
Ditto than farm-yard manure	5	3	6
Ditto than the average of the two	3	3	6

—*Evidence of James Smith, Esq., of Deanston. Report of Health of Towns' Commission.* Part ii., Appendix, p. 328.

7. *Though the employment of liquid manure is, as yet, by no means general, instances of increased produce attending its use are on record, and very striking illustrations have been afforded of the increased value which it gives to land.*

The following extracts refer to the city of Edinburgh :— Application of Sewage to lands near Edinburgh.

"In the case of Edinburgh the increase of the value of poor lands thus irrigated, is shewn to have been from 30*s.* to 15*l.*, and, in some cases, to 20*l.* per acre; other lands, once let for 40*s.* to 50*s.* per acre, now let for very high sums. It is true, that the inhabitants around those meadows object to it as offensive; the value, however, of the irrigation is seen by the parties interested in about three hundred acres of land, estimating the compensation that would induce them to discontinue that practice at the sum of 150,000*l.*"—*Evidence of Mr. Roe, C. E. Health of Towns' Commission.* First Report, p. 407. Increase of value from 30*s.* to 15*l.* or 20*l.* per acre.

"The practical result of this application of Sewer Water is, that land which let formerly at from 40*s.* to 6*l.* per Scotch acre, is now let annually at from 30*l.* to 40*l.*; and that poor sandy land on the sea shore, which might be worth 2*s.* 6*d.* per acre, lets at an annual rent of from 15*l.* to 20*l.* That which is nearest the city brings the higher rent chiefly because it is near and more accessible to the points where the grass is consumed, but also partly from the better natural quality of the land. The average value of the land, irrespective of the Sewer Water application, may be taken at 3*l.* per imperial acre, and the average rent of the irrigated land at 30*l.*, making a difference of 27*l.*; but 2*l.* may be deducted as the cost of management, leaving 25*l.* per acre of clear annual income due to the Sewer Water."—*Evidence of James Smith, Esq. of Deanston. Report of the Health of Towns' Commission.* Part ii. Appendix, p. 326. Increase of value from 2*l.* and 6*l.* to 30*l.* and 40*l.* per acre. Also from 2*s.* 6*d.* to £15 and £20. per acre.

Average original value £3, average value after irrigation with Sewer Water, £30; difference, £27. Clear annual income due to Sewer Water, £25.

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Lowest value, £20; average, £40.

"The lowest sum obtained per Scotch acre for meadow land in the vicinity of Edinburgh, irrigated with the refuse of that town, is 20*l.*, and the average amounts to about 40*l.*"—*Evidence of Dr. Lyon Playfair.* Ibid., Part ii. Appendix p. 46.

"The value of town manure may be estimated by the fact, that a portion of the drainage of Edinburgh spread upon certain level lands towards the sea has increased the value of these lands by more than 5,000*l.* a year; and that, if the whole drainage of London could be so used, at a sufficient distance from the town, the value would exceed 500,000*l.* a-year. Now engineers, who pump from the Thames many miles above London to supply pure water to the inhabitants, could as easily, by pumping away to any desired distance the fluid from the drains, supply the most valuable manure yet known (fluid town manure) to the horticulture and agriculture of the district; and the purity and beauty of the Thames, where it passes through London, would be preserved."—*Dr. Arnott's Report on the Fevers which have prevailed in Edinburgh and Glasgow*, p. 12.

The value of the drainage of London exceeds £500,000 a year.

Land so manured yields from three to six cuttings in the season.

"The *water containing the soluble parts is of great use*, and is carefully applied to the irrigating of grass-lands." "Such ground is annually kept in grass, and yields from *three to six cuttings* in the season."—*Extract from a letter of Mr. Thomas Oliver of Lochend, addressed to a Committee of Gentlemen appointed to Report upon Mr. Martin's Plan, printed* 1836.

"By this water (The Sewer Water of Edinburgh) about 150 acres of grass-land, laid into catch-work beds, is irrigated, whereof upwards of 100 belong to W. H. Miller, Esq., of Craigintinny, and the remainder to the Earls of Haddington and Moray, the heirs of the late Sir James Montgomery, and some small patches to other proprietors. The meadows belonging to the last-mentioned nobleman, and part of the Craigintinny meadows, or what is called the Old Meadows, containing about fifty acres, have been irrigated for nearly a century; they are by far the most valuable, on account of the long and continual accumulation of the rich sediment left by the water; indeed, the water is so very rich, that the proprietors of the meadow lying nearest the town have found it advisable to carry the common sewer through deep ponds, where the water deposits part of the superfluous manure before it is carried

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over the ground. Although the formation is irregular, and the management very imperfect, the effect of the water is astonishing; they produce crops of grass not to be equalled, being cut from four to six times a-year, and given green to milch cows. The grass is let every year by public auction, in small patches, from a quarter of an acre and upwards, which generally brings from *24l.* to *30l.* per acre. This year (1826) part of the Earl of Moray's meadow gave as high as *57l.* per acre."—*From Mr. George Stephen's Essay on Irrigated Meadows, published in* 1826, pp. *72*, *73*.

Four to six crops of grass a year.

The grass let at from £24 to £30 an acre, and in one instance as high as £57.

"There is a letter to me from the late Mr. Oliver, a man who rented some blowing-sand in the neighbourhood of Edinburgh, and who, by making the drainage of Edinburgh pass over it, fertilized it to that extent that he actually grew grass through the winter nearly, which he sold at so much an acre by auction, generally fetching *20l.* or *25l.* I went to see him, and I lived two days with him, and ascertained the fact. In the letter I have referred to, he says, "I care nothing for the solid; I would not give a fig for all they could give me at Edinburgh." He says, "The only valuable part is the supernatant liquid."—*Evidence of James Smith, Esq. Report of Select Committee.*

The solid matter of no value. The only valuable part is the supernatant liquid.

"Some of the meadows irrigated by the Sewage Water of Milan yield a net rent of 11*l.* per *tornatura* (a measure of 10,000 square metres, equal to about two acres and a half), besides a land-tax of 61 francs 10 cents, the expenses of administration, repairs of buildings, &c. These meadows are mowed in November, January, March, and April, for stable feeding; in June, July, and August they yield three crops of hay for the winter; and in September they furnish an abundant pasture for the cattle, till the begining of the winter irrigation."—*First Report of the Health of Towns' Commission.* Vol. ii. p. 403.

Application of Sewage at Milan. Seven crops of grass a year besides pasturage.

The value of this mode of Agriculture has also been proved on an extended scale, in the Duke of Portland's water meadows at Clipstone Park. The course they pursued has been chiefly one of irrigation, the water being but slightly imbued with Sewage Manure. It is, however, a striking illustration of the still greater advantages obtainable from Sewage Manure.

The Duke of Portland's water meadows at Clipstone Park.

"The land immediately occupied by these meadows was, in its wild state, a line of hill-sides covered with gorse and heather—a rabbit warren, over which a few

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sheep wandered—and a swampy valley below, thick set with hassocks and rushes, the favourite haunt of wild ducks and snipes; through which the little stream, the Maun, wound its way in its descent from the town of Mansfield.

"The whole tract, both upland and lowland, was of very little value. The valley was in many parts from nine to ten feet deep in bog, and almost worthless; the hill-sides varied in quality, but 80*l.* a-year would have been a full rent for the 300 acres. Indeed the whole of the Clipstone Park Farm when taken in hand in the year 1816, containing 1,487 acres, had been let for the sum of 346*l.*

Increase of value from 4*s.* 6*d.* to £11 4*s.* per acre.

"The effect of this irrigation has been to raise the annual value of this land from 4*s.* 6*d.* to 11*l.* 4*s.* per acre." —*Journal of the Royal Agricultural Society of England.* Vol. i. 1840, p. 356, 367.

In Dumfriesshire, the value of land raised from £4 to £15, and £20, by irrigation with Sewer Water.

"I met with a small instance last year in going through Dumfriesshire, and passing a little town there, in valuing the land for a railway, some little meadows and parks of ground in the immediate vicinity of the town, worth about 4*l.* an acre; I came to one that I found in a more enriched state, and looking about I found the Sewage Water from the town came upon it; I was rather in a difficulty to know what value to put upon it. I went and investigated the matter; I got the people who rented it; they were paying from 15l. to 20l. an acre for that land, and the same land elsewhere was worth about 4l.; this I was obliged to put down in my valuation as worth from 15l. to 20l."—*Evidence of Mr. W. G. Jolly,* p. 99.

8. *Sewer water has been advantageously applied both to pasture, arable, and garden ground, and with the very best effects to a vast variety of produce.*

Pasture.

Mr. James Norris, market gardener, Sion Hill, Isleworth, in answer to the question, "Have you used Sewage Water at all?" says—"Yes, a great deal of it; we have used it for some time, on the meadow land principally; little, in fact none, on the garden land; we have not had enough of it. It is the drainage of the yards. We draw a great deal of manure from London, in the waggons; that lies in large heaps: every fall of rain that comes upon it drains it away into a large hoe; when full we draw it away in water-carts, and water the meadows. We have had a very great effect

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this year; I think the greatest crop I ever saw on a field we have been dressing."—*Report of Select Committee*, p. 50.

"I may also mention another experiment made upon a farm at Glasgow, where the liquid manure was put over the land, and the growth has continued during the whole winter in a very remarkable way. No doubt the last season has been a remarkable season for grass everywhere; but notwithstanding that, this was distinguished before all the grass of the country round. I saw, about the 1st of December, 43 Irish bullocks wading to the fetlocks in grass upon some of these fields, and eating it most greedily, while the fields upon the farms in the neighbourhood were perfectly bare. I have a report with regard to its progress this year, and the advance of the grass has been very remarkable throughout. The proprietor, although requiring the greater part of the grass for his own use, has let a part of it to see what it will bring. He has got for it (land he could not before have let for more than perhaps a couple of pounds) 8*l.* this year. He considers it to be let very much below its value; so much so, that having given notice of a public sale, he stopped it, expecting, of course, to make more of it by keeping it himself."—*Evidence of James Smith, Esq. of Deanston.* Ibid., p. 15.

Increase of value from £2 to £8 an acre.

A gentleman near Dumfries has made a tank, into which he has carried all the water from his farmstead and his house, the sewage of his house, and also has put in some solid manure, and has applied water to it; and just with a common pump, which is worked by two men, he has been, during the whole of this winter, irrigating his lawn, and he says he has the most beautiful flush of fine grass upon the lawn; and as the thing is done in the morning early, they have no annoyance whatever from any smell from throwing it upon the surface; and by doing it with the hose-pipe, he does not cut any notches in the ground: the smoothness and uniformity of the lawn is completely preserved.

Use of the Italian rye grass.

At the annual meeting of the Yorkshire Agricultural Society an interesting discussion took place on the preservation and application of liquid manure, when

"William Dickinson, Esq., of Willesden, near London, after strongly recommending the use of covered drains for the preservation of ammonia in liquid manures, stated that by the use of liquid manure he had last year produced ten crops of grass in succession upon the same land. The first was

Mr. Dickinson of Willesden.

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cut in March, with about ten inches of grass; it was cut a second time on the 13th of April; a third time on the 4th of May; a fourth time on the 24th of May; a fifth time on June the 14th; a sixth time on July the 22nd, with ripe seeds, and three loads of hay straw to the acre. Immediately after each of these crops, the land was watered once from a London street water-cart, with two parts of urine from the stables, and one part of water; the produce of each crop increasing with the temperature, from three quarters of a load per acre as hay, to three loads per acre.

Mr. Dickinson's Evidence.

The following is an abstract of Mr. Dickinson's evidence before the Select Committee on Metropolitan Sewage Manure:—

Italian rye-grass.

It (the liquid manure from the stable) is conveyed to this tank, from which it is pumped into a water-cart, conveyed and mixed with two parts of water, if the temperature is as to-day; but if it were lower, we should mix it with one part of water; and in the winter season, we should put it on neat, to raise the temperature of the earth; the result of which has been, that I grew, the year before last, nine or ten crops of valuable grass, upon the same ground. The soil was a surface of clay, with a subsoil of clay, so bad that the Norfolk man said, "I would not have your farm as a freehold;" and the Lincolnshire man said, "I would not give you 12*s.* an acre for it, if it was at my own door." The first was less than three quarters of an acre; that was mown nine or ten times the year before last, in the course of twelve months. The grass increased in height as the temperature of the atmosphere. Some of these crops were three feet high, some of them more than three feet. They varied from ten inches or a foot, up to three feet six inches high. In the present year, in January, was cut the first crop, which weighed 2lbs. per yard, upwards of four tons per acre. The crop has increased in height every cutting since. The fifth is now growing upon the ground; the fourth is cut. I should say the second cutting was nearly twenty inches high. I did not weigh that; I should think it twice the weight of the other, or more than eight tons of the green grass. The third and fourth have been greater still.

Both in May and June the quantity of cuttings was beyond eight tons each time. If I were to state twelve tons, I should be within the truth, I am certain. This matter

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is so often disbelieved, that I am rather cautious of saying what really does take place.

They (the oats and tares) were so wonderful after the grass, that I took them as samples to the agricultural show at Beverley; and the Yorkshiremen were astonished beyond measure at the grass report. Their argument was this: "You have exhausted your soil." I said, "I was aware that you would say so, and therefore I have brought the plants of the tares and the oats." The number of grains was astounding, so that there might have been in the earth the remains of the power of this urine used to the grass before. Oats and tares

From 3,000 to 3,500 gallons of water are sufficient for an acre. I calculate 1,100 gallons of urine and 2,200 of water. Four acres kept 100 horses in grass-food till I was obliged to shut up my grass for seed. I have grown a yard of grass in twenty-one days.

"Mr Harvey, a gentleman of Glasgow, has applied it (Sewage Water) to some wheat land before the crop was sown, and he has had a luxuriant crop, more so than the other crops in the neighbourhood, and upon land which was rather cold, backward land."—*Evidence of James Smith, Esq. of Deanston. Report of Select Committee on Metropolitan Sewage Manure,* p. 35. Wheat.

"Mr. Machray, a coach proprietor of Aberdeen, took the Sewer Water of that town, catching it in an old barge, carrying it across the river, and pumping it into carts, and throwing it over his farm. The results were very great indeed; it was tried upon grass, barley, and turnips, and the superior crops raised from a small quantity of this sewerage water was remarkable."—*Ibid.* p. 17. Barley, turnips, grass.

"A second experiment was made in raising turnips upon a similar soil. Also at Stirling to the extent of a quarter of a rood, with two tons of Sewer Water, equal to 32 tons per acre, costing 8s., the produce 28 statute acres of bulbs; so that a ton of Sewage Water very nearly raises a ton of turnips."—*Ibid.* p. 13 Turnips.

"This person has also tried it upon some oats, and creditable persons who have inspected it agree in stating, that part of the oat-field dressed with this manure is very remarkable; the one is a full and fresh crop, and the other is very scanty and poor indeed. Last year, towards the end of the autumn, this person had a field of Swede turnips, which were looking very backward and had not taken well Oats, turnips.

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with the manure; they did not come on well. He applied this liquid by running it by these pipes down between the drills. In three or four days after he had made this application, he applied it to the bottom of the drill (not upon a high-ridged drill, but the bottom), and the crop began to show symptoms of improvement immediately. I saw it at the end of the season, and a more bulky crop of Swedes I have not seen. He attributed it entirely to the application of liquid manure; he said if it had not been for that, he is sure, from the appearance of the plants, he should have lost the crop."—*Ibid.* p. 15.

Gardenground Mr. Wilmott's strawberries.

"In Kent, go where we will, we find the soil cart; the manure cart is in the background somewhere or other; they are unwilling to show it where they grow vegetables. They take the night-soil into Essex, they cart it twenty miles, then reduce it to liquid, and use it. I saw Mr. Wilmot's strawberries, which are well known at Isleworth, and he assured me (and I hope he will be examined as a witness here) that it was worth his while, his ground being at the back of the union house, and that draining upon his land, to make a tank there, and collect the refuse from the union house, cart it from thence upon the hill on the opposite side of the high road, and then water his plants with it; and the difference between the plants watered by that, and those manured in the ordinary way, is greatly in favour of the liquid manure; and if it would pay him to do it by such an expensive mode as that, there can be very little doubt about the result; of course, farmers could not afford to expend the same sum in labour."—*Evidence of W. C. Mylne, Esq. Report of Select Committee on Metropolitan Sewage Manure*, p. 27.

"I sank a well, and erected a privy over it for our men (who number from twenty to forty) to resort to. In this well I fixed a pump to get up the liquid matter, which, when diluted with water, I have found of great service to roses, peach-trees, and many other trees and plants whose names I am not at this moment prepared to enumerate."

Peach trees, roses, &c.

"All those plants termed "gross feeders" seem to delight in it. I think it particularly suits those of rather thickish fibre."

Roses, evergreen oaks.

"Roses in pots particularly; evergreen oaks, in pots, to which we apply this liquid manure, perhaps twice or three times a week, in a very strong state, without fear now at all."

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"I am sure that for cabbage and lettuce, cauliflower, peas, beans, and French beans, and for all those things that have a great effort to make in a short time, and want a stimulus, it would be found one of the very best; an excellent stimulus."—*Evidence of Mr. J. Knight of Chelsea.* Ibid. p. 47. Cabbage, lettuce, cauliflower, peas, beans, and french beans.

"I have known some instances, where the land has been favourably circumstanced, where the water has been applied to drill crops, such as peas, beans, and the usual garden products, with which it was very successful, especially with strawberries, producing more abundant crops, and much earlier than could have been obtained by any mode of top-dressing."—*Mr. James Dean, First Report of the Health of Towns' Commission.* Vol. ii., p. 406. Peas, beans, strawberries.

9. *There is every reason to believe that the Sewer Water will be in large and constant demand at every season of the year.*

EVIDENCE AS TO THE DEMAND FOR THE SEWER WATER.

"We have done fifty acres of meadow; we do that with nothing but this drainage from the yard, and find it better on meadow land than solid. On garden land we have not tried it, only in one instance; we should be induced to try it to a great extent if it was cheap. The Sewer Water likely to be in great demand.

"If it was delivered by cock, we should be induced to use an immense quantity, 100 tons to the acre a year, or more; 30,000 tons in a year."

"In answer to the question, 'Would you pay 2*d.* a ton?'—The witness says, 'Very glad to do it.'

"'Would you not be inclined to go half a mile with a cart?'—'We draw it more than half a mile now.'

"'Did you sign a petition in favour of this?'—'Yes, I did.'

"'Can you speak to any of the parties who have signed that in your neighbourhood?'—'I think that the people are all in favour of it; the large holders of land.'

"'All holders of land and market gardeners?'—'Yes.'

"'That you can speak to, that the large holders of land and market gardeners are in favour of some such measure as this?'—'Yes.'"—*Evidence of Mr. James Norris, Market Gardener, Sion Hill, Isleworth. Report of Select Committee,* p. 51.

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The Sewage Water can be applied all the year round.

"By proper regulation, and with a little experience, the water can be disposed of all the year round. I am very well acquainted with irrigation and the various processes in agriculture; and looking at it with that experience and knowledge, I am satisfied that we shall find a regular and steady consumption for the water every day in the year."—*Evidence of James Smith, Esq., of Deanston.* Ibid. p. 8.

"What I chiefly wish to explain is the mode in which we can apply it during the whole season to tillage land. We will begin with the autumn, when the crops have been separated from the ground; it may be applied at the beginning to land to be in wheat; it may be applied during the whole winter, at any time that may suit the convenience of the farmer; to all lands in any condition, even stubble, or in furrow, or in grass, to be ploughed; that may be continued until past Christmas. Then after that I should say they would find an advantage in giving an application of the liquid manure to winter crops, to their wheats. Then land will be preparing for the spring crops, and that land can then get an additional quantity when it has been tilled and turned over. There would then be the coming of the spring crops; they would require some application to promote their growth after the plant is fairly fixed in the ground. Then there will be the preparation of land for potatoes; then follows the preparation of land for the turnips—a succession of turnip crops and vetches, and crops of that kind. Then part of the meadow land will have been cut for early hay; the hay would be possibly earlier when it is plentifully manured in this way than otherwise; all that hay would require the immediate application of Sewage Water to encourage its growth for the next crop. Then there would be a succession of hay crops during the summer, advancing to the end of July, according to circumstances, and according to the progress the crop has then made from its former cutting. Then from August there will be constant application; a second application of Sewage Water for promoting the growth of green crops, mangel wurzel, and all crops of that kind. That will go on taking advantage of the whole application that can be given until we come again to autumn, and commence again the same circle of application." Ibid. p. 25.

"I have no doubt the farmers will find it to be to their

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advantage to have some store of it. I should say, instead of making dungsteads, as at present, in an open position and exposed to the atmosphere, when they come to know better the fact and advantages of using this liquid they will make their dungsteads in covered tanks, and fill these tanks with our liquid, and mix it with their manure; and if that could prevail to a certain extent, it would enable us to dispose of the liquid at times when it was not so convenient to put it upon the land." Ibid. p. 12. Will be used for moistening dung-heaps.

"There is another way in which it will be disposed of, and that is for watering the dungheaps of all the farmers. There is an immense waste of the very best manure constantly in the country, by the neglect of watering the manure heaps, and this will give great facility for that; and I am quite sure they will be able to add very considerably to the value of the ordinary manure by drenching it from time to time with the liquid manure." Ibid. p. 6.

"I may mention, as connected with our pumping the sewage, that I have no doubt that when pipes are laid down upon farms for the distribution of the liquid manure, that great benefit will be derived in dry seasons from watering the land with common water. I do not doubt that when the system has once been fairly carried out, and people have confidence in it, that we shall see an establishment in every district, not only for the carrying of the sewage manure of the district, but for the purpose of supplying water to the fields." Ibid. p. 18. For irrigation in seasons of drought.

"It would be a very great advantage in a dry season; I am quite sure, in perhaps one summer out of three, that the power of giving water, whether common water, but more especially water mixed with a proportion of Sewage Water in it, would be a very great advantage to land, to give it in a dry period, such as we have seen recently. St. James's Park has been quite brown, and over a considerable district of country many of the crops have suffered very much from the continuance of the dry weather. If there had been power to administer some of this liquid to that land, it would have prevented the decay that has taken place." Ibid. p. 86.

"I have paid attention to the subject of warping, just putting it on; the water is brought in from the sea, and it is formed into a reservoir, which makes a deposit, and the water is let off after the tide has gone out, and thus accumulates a quantity of soil upon it; your sewerage water Warping.

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might be applied in the same way; if you could command a quantity of land within the precincts of London in which you could form it into a level plane, so as to warp it in the same way, the deposit would settle of itself, and leave behind it a valuable residuum for the land, the most valuable in the kingdom."—*Evidence of Mr. D. Magnay, Farmer and Land Agent*, p. 145.

How the expenditure on Sewer Water will be repaid to the farmer.

"Now, in the event of the Sewage Water being sent to the country, it would be some time before people found out what was best for their interest. I suppose they would find this; that it would be an advantage for every farmer to have a greater proportion of his land in meadow, and to irrigate it to the extent we propose, and as much proportional extent as I have stated here. In the first place, they would find great advantage to their home farm, from having a proportion of the land irrigated, and growing a large quantity of food. It would enable them to keep more cattle; those cattle would make an ample return for the food raised for them; they would have the further advantage of raising a greater stock of solid manure: and although I do not doubt that they might supply themselves completely with our liquid manure, without having recourse to solid manure at all, at the same time I think they will have a better cultivation, and more abundant crops, by using a proportion of solid manure—that manure which they will make upon their farms. If we compare the condition of the country round London at present, the general condition of it, with the condition of small portions where there is irrigation and proper management in the application of the manure, we shall find the latter produce one, two, three, and in some cases four-fold. Now one benefit that would arise from the whole of the farmers of the district round London having it in their power to apply the manure would be this, they would bring the whole extent of the land within that range to the highest state of cultivation. We see amazing crops raised in the market gardens, and it is not merely by raising a large crop of its kind, but two and three crops in a year. When land is in a very rich condition you can manage to raise two crops, and in some instances three crops, in a year; and it is by that means the farmers will be enabled to repay the expenditure they may make upon our sewage."—*Evidence of James Smith, Esq. of Deanston.* Ibid. p. 33.

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10. *There are also some incidental advantages attending the use of liquid manure; such as a more rapid growth of the plants watered by it, and the destruction of some kinds of insects.*

"A great, but not sufficiently estimated advantage, which arises from manuring with urine, consists, undoubtedly, in the quicker return effected on the capital of manure, in consequence of its being applied to plants already in a growing state. In the case of manuring with solid excrements, a period of two or three years may elapse before complete decomposition ensues, and the plants have derived the full advantage. The crops, too, during this period, lose much of the manure, in consequence of its best portions being drained away by the snow and rain-water." A quicker return on capital by the use of liquid manure.

"Lastly, one of the uses of manuring with urine, which has hitherto been little regarded, consists in this,—that earth-worms, and the larvæ or grubs of various insects, which in many countries, for instance, on the Upper Weser, do such extraordinary injury to the young rye, are destroyed by it; this effect is produced, as my own experiments made expressly on this point have shown, by the ammonia of the urine; for, if we water a field much infested with earth-worms, with a solution of carbonate or caustic ammonia, the worms come immediately to the surface, writhe for some time, and then die. Probably, also, the cock-chafer grub, when not too deep in the ground, might be destroyed in the same manner; a fact that would be of great importance to many districts."—*On Animal Manures, by Professor Sprengel. Journal of Royal Agricultural Society.* Destruction of insects.

11. *It is admitted on all hands that the value of the Sewer Water is such as amply to repay the expense of its conveyance.*

"If the contents of all the sewers could be brought to a convenient situation for disposal, it would sell for a very considerable sum, and amply repay the cost of any means that might be used to bring it there."—*Mr. E. Cresy. First Report of Health of Towns' Commission,* p. 152.

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12. *It is also proved that the conveyance by pipes is by far the most economical means of transport, and on comparing the relative expense of conveying solid and liquid manure, we arrive at the important conclusion, that the cost of conveying liquid manure by pipes is perfectly insignificant as compared with the cost of the transport of solid manure by carts, while the cost of distributing the liquid manure over the land is but a fraction of the expense attending the application of the solid manure.*

Economy of the conveyance by pipes.

"We can deliver a ton of water at eleven miles distance, and at the altitude we propose to deliver it at, covering all our expenses, and leaving a handsome profit, for 2*d.* per ton."—*Evidence of James Smith, Esq., of Deanston.*

The cost of transmitting water to a distance of five miles, and to a height of 200 feet, including wear and tear of pumping, machinery, fuel, labour, interest of capital invested in pipes, reservoirs, engines, &c., amounts to about 2½*d.* per ton. The cost of cartage to the same distance and height will, under favourable circumstances, amount to 4*s.* per ton."—*Evidence of T. Hawksley, Esq. First Report of the Health of Towns' Commission*, p. 322.

"It is quite clear that a very great weight of liquid material may be moved by pumping more cheaply than by any other known mode of conveyance." Ibid. p. 322.

The cost of conveying the refuse of towns may be greatly reduced.

"On a full examination of the evidence adduced, and of the evidence indicated, it will, I trust, be found to be satisfactorily established, that the houses of towns may be constantly and rapidly cleansed of noxious refuse by adaptations of drains and public sewers, and that by such adaptation, for one street or one district cleansed at the present expense, three may be cleansed by the proposed mode; that the natural streams flowing near towns may be preserved from the pollution caused by the influx of the contents of the public rivers, by the conveyance of all refuse through covered pipes; and that the existing cost of conveyance, by which its use for production is restricted, may be reduced to less than one-fortieth or fiftieth of the present expense of removal by hand labour and cartage."—*Report of the Poor Law Commissioners*, &c. p. 63.

Water conveyance a fortieth of the expense of cartage

"By the application of capital and machinery, the cost of conveyance of substances in suspension in a fluid, even at the Water Companies' prices, may be rendered thirty and even more than forty times as cheap as collection by hand

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labour and removal by cartage. In the metropolis, where the persons who water the roads may obtain water gratuitously from pumps, the water supplied by stand-pipes by some of the Water Companies at 1*l.* per 100 tons is found to be twice as cheap as the mere labour of pumping the water into the cart."—Ibid. p. 53.

In reference to the economical management of liquid manure, Mr. Dean says:—

"The expense of distributing the same quantities of manure, irrespective of the different degrees of productiveness from the different modes of application, would be on the average, for distribution in the solid form, about 3*l.*, and in the liquid form by irrigation, about 6*s.*"

13. *The practicability of the plan of the Metropolitan Sewage Manure Company is amply proved by experiment.*

Distribution by the jet.

Experiment by Mr. Smith of Deanston.

"The water could not well be distributed over the open tillage land by irrigation; it would therefore be necessary to resort to some mode of distributing it by jet. This requires the conveyance of the water in pipes, under a pressure of from 100 to 150 feet of altitude, to a number of convenient points in the different farms where it is to be used. In this there is no difficulty: it is a simple engineering question, the success of which is certain, while the cost can be estimated on known data. I made an experiment, on a large scale, at the Southwark Water Works, which satisfied me of the practicability of distribution by the jet. With an altitudinal pressure of 120 feet of water, and using a 2½ inch hose with a discharging orifice or nozzle of one inch in diameter, I found that I could, from one point, distribute water over an area of two statute acres—but, to be safe, say one statute acre. Dividing the quantity so required annually into three portions, for separate applications, one jet of one-inch orifice will deliver each portion in about an hour, as ascertained from data founded on an experiment made the same day to ascertain the quantity of water discharged in a given time from a similar orifice with a similar pressure."—*Evidence of James Smith, Esq. of Deanston. Report of Health of Towns' Commission.* Part ii., Appendix p. 327.

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The following account by Mr. W. G. Jolly, Land Agent, in Scotland, of the application of liquid manure, upon a farm in the neighbourhood of Glasgow, belonging to Mr. Harvey, is highly important; it has been in operation for two years.

The liquid employed is the waste from the byres and stables, and from a distillery, collected and pumped up by the same process as I understand this company mean to use, over a stand-pipe, and carried out nearly two miles in a direct line through the fields, three to four miles of pipes altogether.

Mr. Harvey keeps from 400 to 500 cows, and has a distillery on the premises; it is all collected in a well; the steam-engine there is for the purposes of the distillery, which pumps this up over the stand-pipe.

It also contains human manure to a very small extent.

It is taken out in cast-iron pipes, three inches in diameter, through the fields; and there are cocks at different parts, and a hose is applied, which goes from any part, and is then distributed by tin pipes added on, so many of them about six feet six in length, and the others about three feet in length. There is no labour, but a single man or boy to watch it and distribute it over; they may do it by jet. He does not use a jet.

Some of the land is in ridges, and some of his fields are flat; and it has a much better effect when the land is flat; on a ridge it is apt to run into the furrows.

It is found to distribute it very equally over the land; and though it is run on at every three feet or three feet and a half, you would not know the difference of the crop, unless they miss a bit, and then it is marked.

I should say that the distribution of manure in that way is by no means so offensive as by applications of common farm-yard manure.

I saw the tanks full and empty, and particularly wished to examine whether there was any deposit; they have never required to be cleaned out, except at first. They put up an agitator to take it all, supposing the article to be deposited the best of it; they found out by experience that it was by no means the richest part, and they have ceased to use the agitator, by which means the first tank it flows into requires occasionally cleaning out.

Applied with good results to all sorts of crops.

He farms various qualities of land; and he has applied it to all sorts of crops, and with universally good results.

On pasture-land it has had the most beautiful effect; the

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cattle seem to like the parts done with it; they eat it much more greedily; if a part is missed, the cattle will leave that. The grass grateful to cattle.

I should say that land that formerly he could not cut more than once, he will cut this year three times. It is common rye-grass.

This year he has applied it to oats, after they were brairded; most of the people thought it would have destroyed them. I went back afterwards, in five or six weeks, and the effects were wonderful; I should say double the amount of the crop upon the part done with it, compared to the part that was not, and so distinctly marked, that at half a mile distance you could see the parts missed; the field is cold clay land.

I estimate the crop at double what it would have been without it. I could not say how many quarters, with any accuracy, at that stage of the crop.

From the dressing he is in the habit of giving per acre, he has a much greater result than from any quantity of farm-yard manure I have seen applied.

He has 300 acres, which is now nearly all in fine condition from that; and I should think, from the supply, that he has equal to twice 300 acres; he has more than he requires—so much so, that after this year, he will not require any solid manure; he is selling it.

He put up this apparatus two years ago, and he is so thoroughly convinced of the advantage of it, that he recommends it very strongly.

The following evidence laid before the Select Committee on Metropolitan Sewage, by Mr. Chadwick, is highly important in reference to the applicability of the plan of the Company:—

"In the summer of 1842, I was staying with a friend, Mr. Thomson, of Clitheroe, where Dr. Lyon Playfair was also staying. Mr. Thomson has extensive print-works, where he employs about 1,000 persons, and from the works has much liquid manure."

"Mr. Henry Thomson pumped up the Sewage Water from a well or shaft, into a tank made at the top of a field about eighty feet above the rest of the farm. He found that, under that eighty feet pressure, by means of the hose, with the labour of two men, one to remove the hose, and another to direct the nozzle, they could distribute about 2,000 gallons of liquid manure in an hour."

"The important result was this, that it was to be accomplished by the labour of two men, and suppose we

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Economy of the application by the hose: 6*d.* by the hose, 5*s.* by the water cart, and 11*s.* or 12*s.* for the distribution of stable manure.

give 2½*d.* or 3*d.* an hour, that delivery of the 2,000 gallons was accomplished for 6*d.*" The expense of delivery of the same quantity by water-cart was, I think, about 5*s.*; the expense of loading and spreading stable dung was about 11*s.* That was about the relative mechanical cost:—6*d.* for the delivery by the hose, 5*s.* by the water-cart, 11*s.* or 12*s.* in the distribution of stable manure—an equivalent quantity, and that close to the farm. Then there was this great advantage in favour of the hose, though you cannot give an estimate in money value as to the relative amounts, that in the distribution by the water-carts there is the poaching of the land by the weight of the cart and horse, and probably the damage of which would be more than 5s., and of course still greater damage in the case of the cartage of the heavier produce of stable manure.

Advantage of

With the hose the experiment appeared to be complete, with the addition of a very important fact, that you could by the hose get on the land at any time, but with the water-cart, or in spreading solid manure, of course you are restricted by the state of the weather as to its application to certain periods. So far as they could try, I think these 2,000 gallons of Sewer Water were found equal to about 3 cwt. of guano, and about 15 tons of stable manure. But there was another important point which was established beyond a doubt, which was, that the friction through the hose, for a considerable length, was much less than we anticipated; for instance, we used half a mile of hose, and carrying it on the surface, over furrows and through a ditch and over a hedge, I think at the end of 800 yards it gave out a jet, something, as near as I could judge, of 40 feet—nearly half the height due to the pressure. These experiments appeared to establish the fact, that the hose, in many circumstances, for the delivery of a given quantity of water, even considering it as a means for the distribution of simple water, would have been cheaper than the water-meadow itself; and you have the advantage, also, with that, of being able to apply the liquid manure to arable cultivation. With the water-meadow you only apply it to grass land. "Putting the interest on the machinery and capital together, we could not put down the fair expense of this delivery by the hose at much more than 1*s.* an acre, that is for 2,000 gallons."

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